REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
UN	May 2002	Report -April 2001 - April 2002

4. TITLE AND SUBTITLE
Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) Field Demonstration Report: Air Force Number 6 Fuel Farm, Dobbins AFB, GA

5. FUNDING NUMBERS
Contract#F33601-01-F-9064
PE 62202F
PR 1710
TA 1710D
WU 1710D408

6. AUTHOR(S)
*Reed, Dennis A; *Sterner, Teresa R.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
*Operational Technologies Corp.
1370 N. FairfieldRd, Suite A
Beavercreek, OH 45432

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory, Human Effectiveness Directorate
Biosciences and Protection Division
Wright-Patterson AFB, OH 45433-5707

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFRL-HE-WP-TR-2002-0158

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

A demonstration of the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) approach for assessing human health risk at weathered petroleum release sites was performed at a former above ground storage fuel farm (FF) located at Dobbins Air Force Base, Marietta, Georgia. The fuel farm was used to store and dispense jet petroleum (JP) fuel, blend numbers 4, 5 and 8 (i.e., JP-4, JP-5 and JP-8) over a period of approximately 40 years, from the mid 1950s through the early 1990s. Use of the FF was discontinued in 1993. A preliminary site characterization survey performed in 1997 detected total petroleum hydrocarbon (TPH) at concentrations ranging from 517 mg/kg to 2,239 mg/kg in four of eight grab samples of soil. A total of 15 primary soil samples were collected at depths ranging from 1.0 to 8.5 feet belowground surface to support the TPHCWG demonstration. Grab samples collected in Encore samplers from the sampling interval were analyzed by International Technology (IT) Corp. (EMAX Lab, Inc.) for TPH gasoline range orgaincs (GRO) and benzene, toluene, ethylbenzene and xylenes (BTEX). Soil composited from the sampling interval was split and subsequently analyzed by EMAX Lab for TPH diesel range organincs (DRO) and polycyclic aromatic hydrocarbons (PAHs) and by Operational Technologies (OpTech) Corp (Lancaster Laboratories) for aliphatic and aromatic hydrocarbons fractions.

14. SUBJECT TERMS
Aliphatic hydrocarbons
Aromatic hydrocarbons
Commercial/Industrial exposure scenario
Diesel Range Orgaincs (DRO)
Direct method
Gasoline Range Organics (GRO)

15. NUMBER OF PAGES
82

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

THIS PAGE INTENTIONALLY LEFT BLANK

AFRL-HE-WP-TR-2002-0158

United States Air Force
Research Laboratory

Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) Field Demonstration Report: Air Force Plant Number 6 Fuel Farm, Dobbins AFB, Georgia

Dennis A. Reed
Teresa R. Sterner

OPERATIONAL TECHNOLOGIES, CORP.
1370 NORTH FAIRFIELD ROAD, SUITE A
DAYTON, OH 45432

May 2002

REPORT FOR THE PERIOD APRIL 2001 TO APRIL 2002

Approved for public release; distribution is unlimited

Human Effectiveness Directorate
Biosciences and Protection Branch
Applied Toxicology Branch
Wright-Patterson AFB OH 45433-7400

TECHNICAL REVIEW AND APPROVAL

AFRL-HE-WP-TR-2002-0158

This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

FOR THE DIRECTOR

//SIGNED//

MARK M. HOFFMAN
Deputy Chief, Biosciences and Protection Division
Air Force Research Laboratory

PREFACE

This demonstration project was performed by Operational Technologies Corporation (OpTech) under Contract Number F33601-01-F-9064. OpTech activities were conducted under the Project Management of Dr. Peter Lurker, 1370 North Fairfield Road, Suite A, Beavercreek, OH 45432. Dr. David Mattie of the Air Force Research Laboratory, Human Effectiveness Directorate, Operational Toxicology Branch (AFRL/HEST) at Wright-Patterson Air Force Base (AFB), OH, served as contract monitor.

The authors of this report gratefully acknowledge Mr. Mark Joop of IT Corporation, Knoxville, TN, for sharing his soil samples and the IT staff, Marietta, GA, for assistance with sampling and sample handling. We also acknowledge the technical assistance provided by Mr. Richard Entz of Lancaster Laboratories, Lancaster, PA, for his guidance on analytical methods for petroleum hydrocarbons and for "walking us through" the analytical data. Our special thanks to Ms. Joyce Dishner and Ms. Vicki Graves of IT Corporation, Knoxville, TN, for providing electronic copies of IT's analytical data for BTEX, PAHs and TPH-GRO concentrations in site soils. Without the outstanding support that was provided by all of these people this demonstration project would not have been possible.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

°C	degrees Celsius
µg	microgram
ASTM	American Society for Testing and Materials
atm	atmosphere
bgs	below ground surface
BTEX	Benzene, Toluene, Ethylbenzene, Xylenes
c/c	concentration/concentration
C_{sat}	Chemical saturation concentration
C_{TPH}	Concentration of TPH mixture
DRO	Diesel Range Organics
EC	Equivalent Carbon
EPA	Environmental Protection Agency
FF	Fuel Farm
FID	Flame Ionization Detector
g	gram
GC	Gas Chromatograph
GEPD	Georgia Environmental Protection Division
GRO	Gasoline Range Organics
HI	Hazard Index
HQ	Hazard Quotient
IT	International Technology Corporation
JP	Jet Petroleum
kg	kilogram
K_{oc}	octanol-water partition coefficient
LMAS	Lockheed Martin Aeronautical Systems
MDEP	Massachusetts Department of Environmental Protection
mg	milligram
mL	milliliter
OpTech	Operational Technologies Corporation
PAH	Polycyclic Aromatic Hydrocarbon
ppm	parts per million
QC	Quality Control
RBCA	Risk-Based Corrective Action
RBSL	Risk-Based Screening Level
RCRA	Resource Conservation and Recovery Act
RES	Residual Saturation
RfD	Reference Dose
RFI	RCRA Facilities Investigation
TPH	Total Petroleum Hydrocarbons
TPHCWG	Total Petroleum Hydrocarbon Criteria Working Group
VPH	Volatile Petroleum Hydrocarbon
WDE	Washington Department of Ecology

TOTAL PETROLEUM HYDROCARBON CRITERIA WORKING GROUP (TPHCWG) FIELD DEMONSTRATION REPORT: AIR FORCE PLANT NUMBER 6 FUEL FARM, DOBBINS AFB, GEORGIA

EXECUTIVE SUMMARY

A demonstration of the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) approach for assessing human health risk at weathered petroleum release sites was performed at a former above ground storage fuel farm (FF) located at Dobbins Air Force Base, Marietta, Georgia. The fuel farm was used to store and dispense jet petroleum (JP) fuel, blend numbers 4, 5 and 8 (i.e., JP-4, JP-5 and JP-8) over a period of approximately 40 years, from the mid 1950s through the early 1990s. Use of the FF was discontinued in 1993. A preliminary site characterization survey performed in 1997 detected total petroleum hydrocarbon (TPH) at concentrations ranging from 517 mg/kg to 2,239 mg/kg in four of eight grab samples of soil. The grab samples were collected using a hand auger at depths ranging from one to two feet below ground surface (bgs). Xylene concentrations ranged from 0.026 mg/kg to 0.70 mg/kg. No other benzene, toluene, ethylbenzene or xylene (BTEX) compounds were detected.

A total of 15 primary soil samples were collected on 19-21 September 2001 at depths ranging from 1.0 to 8.5 feet bgs to support the TPHCWG demonstration. Grab samples taken with Encore® samplers from the sample interval were sent by International Technology (IT) Corporation to EMAX Laboratories, Inc., Torrance, CA, for analysis. These samples were analyzed for BTEX and TPH gasoline range organics (GRO). The sample interval was then carefully composited, the composite soil was split, then sent by IT Corporation to EMAX Laboratories for TPH diesel range organics (DRO) and polycyclic aromatic hydrocarbons (PAHs) analyzes, and by OpTech Corporation to Lancaster Laboratories, Lancaster, PA, for aliphatic and aromatic hydrocarbon fractions analyses.

Some BTEX was detected above method detection limits in most of the samples. In five of the samples that contained elevated levels of TPH, benzene concentrations ranged from 1300 μg/kg to 31,000 μg/kg. TPH-GRO concentrations ranged from less than 1 mg/kg to 3,400 mg/kg. TPH-DRO concentrations ranged from 7.8 mg/kg to 9,800 mg/kg. Measured concentrations of TPH fractions (i.e., with all non-detects set to one-half the detection limit) ranged from 42.9 percent to 89.8 percent of the total TPH (GRO + DRO), with an overall average of 67 percent for the five samples containing detectable TPH concentrations. Although better agreement between total TPH and TPH fraction concentrations was anticipated, the differences are probably attributable more to the sample collection techniques than to differences between the analytical laboratories. TPH-GRO and BTEX concentrations were measured from soil collected using Encore® grab samplers. The TPH-DRO, PAH and TPH fraction concentrations were measured from the same soil core segments after the soil was composited.

Flame ionization detector (FID) field screening readings of soil samples correlated poorly with the concentration of petroleum hydrocarbons in site soils. Daily calibrations with methane and functional tests of the FID indicated that the instrument was operating properly. Compositing soil samples in a stainless steel bowl may lead to significant volatilization of lighter TPH constituents.

hydrocarbons in soil collected by two different techniques (grab vs. composite) most likely account for the poor agreement between the lighter aliphatic and aromatic weight fractions and the weight fraction GRO. This limited analysis indicates that the petroleum contamination detected in FF soils consists of relatively fresh product (i.e., contains elevated levels of TPH-GRO and BTEX) and is not related to previous FF activities.

Risk-based screening levels (RBSLs) calculated using the TPHCWG methodology indicated that the subsurface soil indoor vapor inhalation pathway consistently contained the lowest total TPH RBSLs (from 99 mg/kg to 359 mg/kg) for the commercial/industrial exposure scenario. For this pathway all five samples with detectable concentrations of TPH fractions exceeded their respective total TPH RBSLs. The risk is attributable to the high concentrations of TPH in the equivalent carbon (EC)>8-EC10, EC>10-EC12 and EC>12-EC16 aliphatic fractions, and to the high concentrations of TPH in the EC>5-EC7 and EC>10-EC12 aromatic fractions. The TPH "fingerprint" is more characteristic of fresh petroleum products than it is of weathered petroleum compounds.

BTEX concentrations detected in FF soils at the eastern edge of the FF, in the vicinity of the fuel pumps, are well above the State of Georgia's cleanup standards for hydrocarbon contaminated soil. Benzene poses the greatest risk. Its concentration in FF soils is more than three orders of magnitude above the cleanup standard. It is evident from the results of this demonstration that further investigation is needed because the contamination is not likely the result of former FF operations. However, additional sampling and analysis activities to demonstrate the TPHCWG approach are not recommended. The petroleum hydrocarbon contamination detected in FF soils is not sufficiently weathered to effectively implement the TPHCWG approach at this site.

Several key lessons were learned from performing this demonstration at the FF site.

- The same soil sampling technique is necessary to obtain comparable total TPH, TPH-GRO, TPH-DRO, BTEX and TPH fractional analysis data. Whenever possible, the same laboratory should perform all required analyses.
- Direct push sampling generally provides insufficient soil volume from a given sample interval to perform all laboratory analyses required by the prime contractor (i.e., TPH-GRO, TPH-DRO, BTEX and PAHs) as well as the TPH fractional analysis needed for TPHCWG demonstration purposes. Larger down hole sampling equipment (e.g., hollow-stem auger drilling rig with three-inch diameter split spoons) is preferable at TPHCWG demonstration sites where soil samples are split with another contractor.
- Compositing soil samples in a stainless steel bowl may lead to significant volatilization of lighter TPH constituents. The practicality of compositing soil in a sealed plastic bag should be considered. Some soil types (e.g., clay, saprolite) may require extensive "chopping" with the spoon, making this technique difficult to implement.
- Candidate sites for demonstration of the TPHCWG approach should be located in states that apply cleanup criteria based upon TPH concentrations (i.e., TPH-GRO and TPH-DRO), not in states that already applies a form of risk-based cleanup criteria.

1.0 INTRODUCTION

The Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) has developed an approach for establishing soil clean-up criteria, which is protective of human health at petroleum release sites. This approach treats complex petroleum mixtures as a combination of hydrocarbon fractions for conducting environmental modeling and estimating non-cancer risk. Carcinogenic petroleum compounds must be evaluated separately. The TPHCWG approach can be used within a tiered framework to estimate human health risk and to calculate Risk Based Screening Levels (RBSLs). The TPHCWG approach is consistent with U.S. Environmental Protection Agency (EPA) guidance[1] and the American Society for Testing and Materials (ASTM) E 1739 – 95, *Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites* (RBCA)[2].

A former above ground storage fuel farm (FF) contaminated with "weathered" jet fuel (JP-4, JP-5 and JP-8), located at Air Force Plant Number 6, Dobbins Air Force Base, Marietta, Georgia, was selected to demonstrate the TPHCWG approach. A number of fuel spills were known to have occurred at this site and the tank farm was abandoned in 1993, providing sufficient time for weathering of the petroleum hydrocarbons. Field sampling activities at the demonstration site were conducted on September 19-21, 2001 in accordance with the state approved work plan prepared by International Technology (IT) Corporation[3] and the site-specific work plan[4] prepared by Operational Technologies Corporation (OpTech).

1.1 Objectives

The objectives of this demonstration are as follows:

- To effectively demonstrate the utility of the TPHCWG fractional analysis approach in TPH contaminated soil, regardless of fuel type, soil type, environmental setting, or contaminant history.
- To provide additional data on the characteristics of weathered petroleum products in soil to support the development of a cost-effective site assessment program using the Risk Based Corrective Action (RBCA) decision making process.
- To enhance regulatory agency acceptance of risk-based approaches for assessing human health risks at petroleum contaminated sites in the United States.

1.2 Site Background and Previous Sampling Results

The FF at Air Force Plant Number 6, Dobbins Air Force Base, Marietta, GA, is located adjacent to the Naval Air Station, south of the main runway complex. The FF facility was operated from the mid 1950s through the early 1990s. It served as an aircraft fuel storage facility for JP-4, JP-5 and JP-8. The fuels were used to support Lockheed Martin Aeronautical Systems' (LMAS) flight line operations. The facility is approximately 300 feet in width and some 500 feet long. It contains eight 50,000-gallon above ground storage tanks.

A preliminary site characterization survey was performed in 1997 by LMAS prior to the transfer of the property from the Air Force to the Naval Air Station. Eight soil samples were collected with a hand auger at depths ranging from one to two feet bgs. The samples were collected from areas within the spill containment berms, near valves and adjacent to pipe intersections. The eight soil samples were analyzed for TPH and BTEX. Four of the eight

samples contained TPH at concentrations ranging from 517 mg/kg to 2,239 mg/kg. Xylene concentrations ranged from 0.026 mg/kg to 0.70 mg/kg. No other BTEX compounds were detected.

In December 1997 LMAS submitted a solid waste management unit assessment report on the soil contamination detected at the fuel storage facility in accordance with the requirements of the Resource Conservation and Recovery Act (RCRA). On the basis of the information provided in the report, the Georgia Environmental Protection Division (GEPD) directed LMAS to submit a RCRA Facilities Investigation (RFI) Work Plan[3] to determine the nature and extent of contamination at the former fuel storage area.

2.0 SITE SAMPLING AND ANALYSIS ACTIVITIES

Sampling activities at the FF were performed on 19 through 21 September and 24 through 28 September, 2001. Mark Joop of IT Corp., Knoxville, TN, directed the sampling efforts, including soil sampling, installation of piezometers and groundwater sampling. IT Corp split soil samples collected on 19 through 21 September with OpTech for the purposes of this field demonstration. Soil sampling was performed during this period by Mr. Joop and one technician from IT Corp., two Geoprobe operators from Fugro Geosciences Inc. and one OpTech field technician.

Sampling was performed in accordance with the approved RFI work plan[3] and amendments in conjunction with the modified site-specific work plan prepared by OpTech[4], as described below. Operation of down-hole equipment, control of work zones and protection of on-site personnel was conducted as specified in the site health and safety plan[5] as required by the GEPD. Site utility clearances and drilling permits were obtained by IT prior to the commencement of sampling activities.

Hard hats, hearing protection and steel-toed boots were required onsite. Insect repellant and sunscreen were available at all times. Sampling personal protective equipment included disposable aprons and nitrile gloves.

2.1 Soil Sampling

Direct push soil borings were obtained using a track-mounted remote drive Geoprobe®, model number 6610DT (see Photo C-1, Appendix C). Soil cores were collected in five-foot long, two-inch acetate tubes. Borings were advanced from the ground surface to ten feet below the top of the vadose zone.

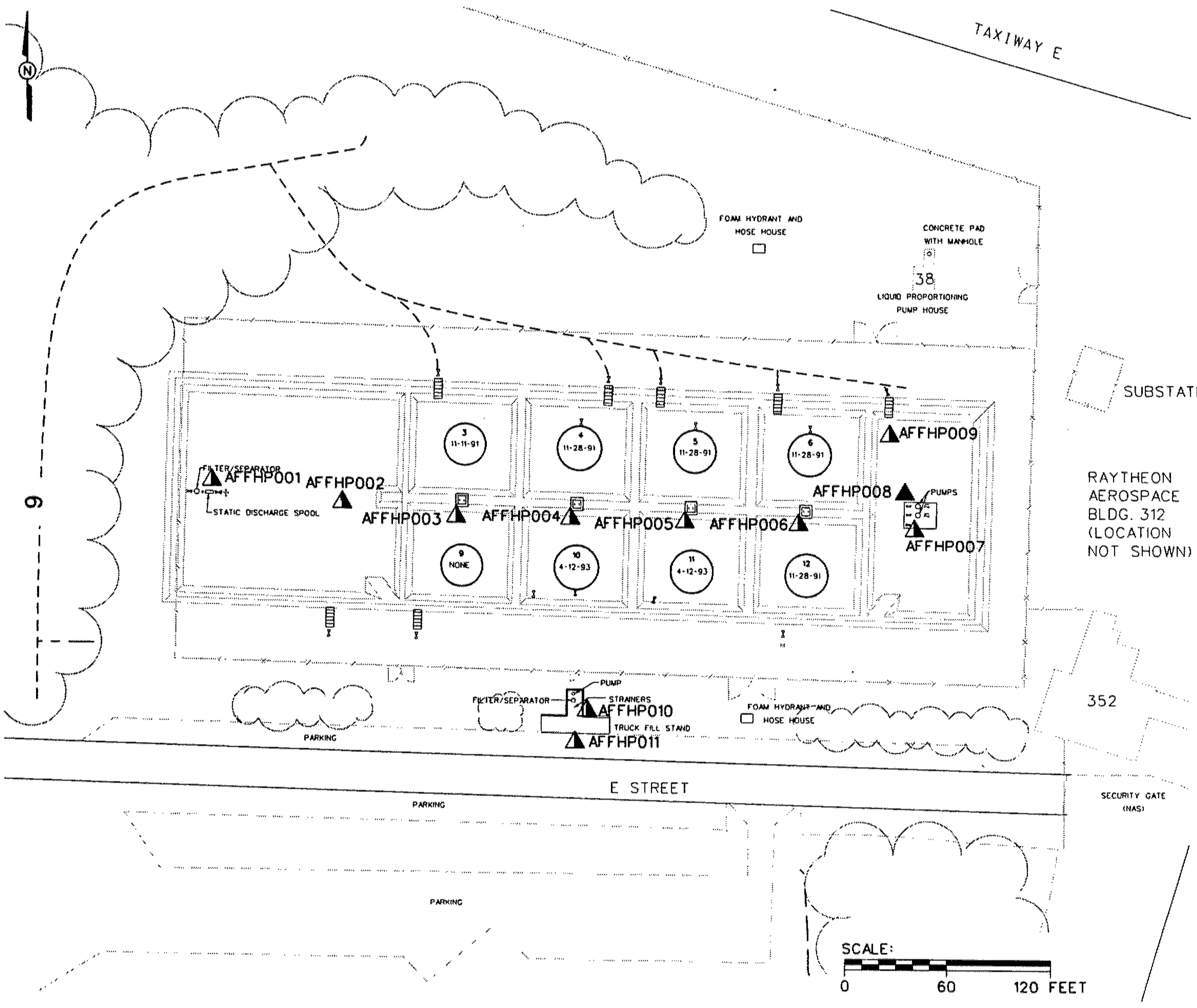
Soil cores were subjected to field screening using a Perkin Elmer PE Photovac MicroFID I/S, IT Electronics Dept # 84337, Flame Ionization Detector (FID) (see Photo C-2, Appendix C). The FID was calibrated with methane at the beginning of each sampling day. To screen the soil cores, a single slit in the acetate tube was made end to end using a box cutter. A screwdriver was used to open the slit at the screening point, allowing room for the FID nozzle inside the core tube. The FID nozzle was held in place until the readings started to decrease; the highest reading was recorded. Cores were screened every foot, starting at the six-inch point. All cores for each borehole were screened until the presence of groundwater was confirmed. FID screening was not performed on saturated soil. Following screening, the cores were placed in the shade until sampling intervals were designated.

Soil cores exhibiting the highest FID reading at each boring were used to obtain the soil samples for this study. OpTech also split surface samples that suggested petroleum contamination through high FID readings (~100 parts per million (ppm) or greater) and/or petroleum odor and staining. Once sample intervals were selected, another slit was made in the acetate tube and a section of the tube was lifted away. A thin layer of soil was scraped from the sampling interval using a stainless steel spoon. IT then collected soil for TPH-GRO and BTEX analyses using three Encore® samplers and spacing the sampling over the interval. Encore® samplers, required for TPH-GRO and BTEX analyses in Georgia, collect a small core of soil in an enclosed tube, which is capped and sealed. Therefore, these analyses were performed on grab samples, not on composite samples.

Following Encore® sampling, the soil interval was placed into a stainless steel bowl and homogenized with a stainless steel spoon (see Photo C-3, Appendix C). IT collected their composite sample for TPH-DRO and selected PAHs analyses. OpTech then filled a 125 mL glass sample jar with the composited soil, allowing minimal headspace, for TPH fractions analyses. A moisture sample was taken in a 4.5 oz. plastic cup and packed in a resealable plastic bag with the 125 mL jar. No preservatives were used in the soil sample containers. All samples were placed immediately in a cooler on ice.

A total of 15 primary soil samples were collected for field demonstration purposes at the locations shown in Figure 2-1. Soil samples were collected at depths ranging from 1.0 to 8.5 feet bgs. In addition, one field duplicate sample plus matrix spike and matrix spike duplicate samples from a single boring were collected and submitted to Lancaster Laboratories. Sampling activities began at the western edge of the fuel farm and progressed in an easterly direction beyond the fuel pumps located at the eastern edge of the fuel farm; sampling sites were determined by the IT work plan[3]. The sites most likely to be contaminated were sampled during the first three days to obtain the best possible samples for this study.

Following completion of sampling activities, ten feet of well screen (20 machine slot) and one-inch piezometers were set at each boring site. The borings were filled with sand and one-foot of bentonite chips and watered in place. The piezometers were developed on the day following drilling and groundwater samples were taken as required by the RFI work plan[3].



LEGEND:

- SOIL BORING/PIEZOMETER LOCATION
- SOIL BORING LOCATION
- EARTHEN DITCH
- CONCRETE-LINED DITCH
- VEGETATION
- FENCE

NOTE:

DATE ON TANK IS WHEN CLEANED AND INSPECTED (DEACTIVATED).

FIGURE 2-1
SOIL
SAMPLING LOCATIONS
AVIATION FUEL FARM

AIR FORCE PLANT 6
MARIETTA, GEORGIA

IT CORPORATION
A Member of The IT Group

2.2 Field Quality Control Samples

A field duplicate sample set was collected from boring number HP006-02 and marked as HP006-11. The duplicate was submitted blind to the laboratory to evaluate laboratory precision, accuracy and repeatability.

Three rinsate water samples were submitted in 40 mL glass vials preserved with hydrochloric acid. Deionized water was poured over a cleaned and dried sampling spoon and caught in a clean sampling bowl. The water was then decanted into the sample vial. The vial was filled to a positive meniscus, the cap replaced and the vial inverted to ensure there were no bubbles trapped in the sample. These rinsate blanks were collected to evaluate the effectiveness of equipment decontamination procedures that were used in the field. In addition, water blanks were filled directly from three different commercially purchased jugs of deionized water to ensure no volatile hydrocarbons were inadvertently introduced during sample collection activities.

Pre-labeled trip blanks from Lancaster Laboratories accompanied samples at the site and during return shipment to the laboratory. A temperature blank prepared by Lancaster was returned with the samples to determine if the arrival temperature met the goal of 4 ± 2°C.

Two jars of composite soil were submitted from boring number HP010-01 for matrix spike and matrix spike duplicate analyses. This soil was judged to be "clean" by 0.0 ppm FID readings as well as through observation (i.e., absence of staining and odor in the sample interval).

2.3 Field Sample Identification

FF borehole designations (i.e., AFFHP001) were assigned in accordance with the sampling protocol specified in the IT work plan[3]; however, the labels were shortened for ease of use (e.g., HP001). HP indicates the samples were collected via hydropunch. The next three characters identified the soil boring number (e.g., 001 for boring number 1). The final characters indicated the approximate depth of the sample (e.g., -01 for 0 to 1-foot bgs). The actual depth of the sample was a range between the starting depth and the ending depth (e.g., 0.5 to 1.5 feet bgs was recorded as 01). Using this sample identification scheme, the example above would be labeled as HP001-01.

2.4 Sample Packaging and Shipping

Samples were removed from the site at the lunch break and at the end of the day; samples were then placed in a designated sample refrigerator until they were packed for shipment to the analytical laboratory. Soil sample jars were placed in resealable bags with the corresponding moisture sample. Water samples were placed in a foam carrier provided by the laboratory.

The sample cooler was packed according to instruction provided by the analytical laboratory. Bags of ice were placed in a second large resealable bag and laid flat in the bottom of the cooler. Heavy cardboard was then placed on top. Cardboard spacers were used to keep samples away from the sides of the cooler and to allow air circulation. Samples were placed within these spacers and covered with a sheet of bubble wrap. Additional double bags of water

ice were packed on top. Completed chain of custody forms were sealed in plastic bags and taped inside the cooler lid. The cooler was sealed around its length and width with strapping tape and the lid/body seam was covered with duct tape; chain of custody seals were placed at opposite corners and covered with packaging tape.

At the end of the third sampling day (i.e., on Sept. 22, 2001), samples were shipped to Lancaster Laboratories and received on the following morning (Sept. 23, 2001). The sample cooler was shipped via Federal Express to the attention of Richard Entz, Lancaster Laboratories, 2425 New Holland Pike, Lancaster, PA 17605-2425. A copy of the shipping documents was retained for project records.

2.5 Field and Sample Custody Documentation

Field notes were recorded in a bound logbook in indelible ink. Notes included:

- Safety briefing times and topics
- Contact numbers
- Equipment types, models and parameters (including FID calibrations)
- Boring information (FID screening results, recovery in each core, groundwater depth)
- Sample information (identification numbers, soil odor and staining, time of sampling, sample depth)
- Sequence of time of rinsate and deionized water samples

OpTech took digital photographs depicting sampling activities and site conditions. Selected photos are included in Appendix C.

2.6 Equipment Decontamination

Sampling tools and bowls were decontaminated using a Liquinox, rubbing alcohol and deionized water solution. Surfaces were scrubbed and then dried with clean paper towels. Sampling spoons and bowls were wrapped with aluminum foil to keep them clean until used. Fugro Geosciences operators decontaminated the Geoprobe® core flights and equipment in contact with the ground using high-pressure hot water. Boring equipment was used once and then stored in a pickup until it was decontaminated.

2.7 Disposition of Investigation Derived Waste

Soil cores were collected in 55-gallon drums and disposed of by IT as investigation derived waste in accordance with the RFI work plan[3]. Disposable personal protective equipment and other sampling trash were disposed of as non-hazardous waste in Air Force dumpsters.

2.8 Laboratory Analysis

Soil samples exhibiting the highest levels of petroleum contamination, as indicated by FID readings and soil characteristics (i.e., stains and odors), were shipped via overnight delivery to EMAX Laboratories, Torrance, CA. Grab samples were analyzed for volatile component

analysis (TPH-GRO and BTEX) and composite samples for TPH-DRO and PAHs. Composite soil samples collected by OpTech were sent to Lancaster Laboratories, Lancaster, PA, for aliphatic and aromatic hydrocarbon fractional analyses following the third day of sampling.

The OpTech work plan[4] indicated that Lancaster Laboratories would perform all necessary analyses for this demonstration (TPH-GRO, TPH-DRO, BTEX, PAHs and TPH fractions). However, IT and OpTech personnel determined on site that the volume of soil was insufficient within the sample intervals for the required number of analyses. For this reason, it was agreed that IT would share its TPH-GRO, TPH-DRO, BTEX and PAHs analytical data with OpTech.

Composite samples sent to Lancaster Laboratories were analyzed for aliphatic and aromatic semivolatiles in the EC8 to EC35 range using a simple extraction with pentane followed by the fractionation of aliphatics and aromatics on a silica gel column (modified EPA Method 3630C). A gas chromatograph (GC) with a FID was used to analyze the different fractions under the laboratory's Protocol 1. The separation procedure is performed using silica gel to fractionate petroleum materials into saturates, aromatics and polars. A 2:3 mixture of methylene chloride and pentane is used for elution of aromatics from the silica gel. Because compounds eluting earlier than C8 normal hydrocarbons are not determined by this portion of the method and compounds are measured beyond EC28 (i.e., to EC35) n-hydrocarbons, an alternative gas chromatographic column (same phase type) is used along with different flow rates and temperature programming. Direct injection techniques and use of hydrogen carrier gas are employed to provide resolution and to limit potential mass discrimination over the working range (>EC8 through EC35 n-hydrocarbons).

Analysis for aliphatic and aromatic volatiles, EC5 to EC8, was performed using the laboratory's Protocol 2. This protocol is a modification of the Massachusetts Department of Environmental Protection (MDEP) "Method for the Determination of Volatile Petroleum Hydrocarbons (VPH)", January 1998, and the Washington Department of Ecology (WDE) ECY 97-602, June 1997 "Method for the Determination of VPH Fractions". Protocol 2 uses purge and trap GC with photoionization detectors and FID. Both the MDEP and the WDE methods include n-pentane in specific summation of data and for instrument calibration. Both methods start with the retention time at the end of n-pentane due to the difficulty in fully resolving pentane from the methanol solvent peak for soils (the MDEP method requires methanol preservation of soils).

Instrument calibration for Protocol 1 is based on the average response for the following alkanes: C8, C10, C12, C16, C20, C22 and C32. Mass discrimination is controlled such that the average response for each target alkane does not vary by more than 15% from the overall average alkane response. For Protocol 2 calibration of <EC5 through EC6 aliphatics is determined based on the response of 2-methylpentane and >EC6 through EC8 aliphatics are based on n-heptane response. This deviates from the WDE method in that the averaged response for n-pentane and n-hexane define the first respective range and n-octane defines the second range. The MDEP method defines the ranges differently (EC5 through EC8) and uses the average response for n-pentane, 2-methylpentane and 2,2,4-trimethylpentane.

3.0 WORKING GROUP APPROACH FOR TIER 1 ASSESSMENTS

3.1 Identification of Exposure Scenarios

A complete exposure scenario includes a source of contamination, a transport mechanism, an exposure pathway and a receptor. For this project it was assumed that contaminants present in surface and subsurface soils are transported via wind erosion, by volatilization to indoor and outdoor air and by leaching to groundwater. Because the fuel farm is located on an active military facility, it was assumed that commercial/industrial receptors exist at the site. Residential receptors were not considered because the site is unlikely to be developed as a residential area in the foreseeable future. Consequently, the following exposure scenarios were evaluated in Tier 1:

- Direct contact with surface soils by commercial/industrial receptors
- Inhalation of indoor air (nearby buildings) by commercial/industrial receptors
- Inhalation of outdoor air (on-site) by commercial/industrial receptors
- Ingestion of groundwater (local well water) by commercial/industrial receptors

3.2 Calculation of Tier 1 RBSLs

Tier 1 RBSLs were calculated using a modified procedure developed by the TPHCWG, which is based upon the standard default equations and geological factors used in the ASTM RBCA process[2]. This procedure differs from the RBCA framework in that it considers additivity of risk. Additivity of risk is usually not considered in a Tier 1 evaluation because RBSLs are generally developed for a limited number of constituents. However, because TPH is a complex mixture, the approach used to calculate TPH RBSLs differs from that used for individual chemicals of concern. Evaluating TPH as a mixture is also important for assessing interactions between different individual chemicals or fractions that impact fate and transport modeling. The TPHCWG RBSL calculations use Raoult's Law to simplify the true behavior of chemicals in a mixture (i.e., assumes ideal solution behavior). Consequently, the actual vapor pressure of the complex TPH mixture may be higher or lower, depending upon the strength of the intermolecular bonds[6]. (Note: To obtain the actual vapor pressure of a complex mixture, the activity coefficients for each constituent must be calculated from physical chemical data (if available) applicable to the conditions (i.e., temperature and pressure) under which the risk estimate is to be calculated).

To incorporate the concept of risk additivity into the calculation of a RBSL for the TPH mixture, hazard quotients (HQs) are calculated for each TPH fraction. Rather than compare each individual HQ to an acceptable value of 1.0, the sum of all the HQ values is calculated to derive the overall hazard index (HI). This HI for the entire TPH mixture (i.e., all fractions combined) is compared to the acceptable risk level of 1.0.

Another important consideration in the RBSL calculation is an upper exposure limit for cross media pathways, such as soil leaching to groundwater or volatilization to indoor or outdoor air. This upper limit, the chemical saturation concentration (C_{sat}) is the soil concentration at which the sorption limits of the soil particles, the solubility limits of the soil pore water and the saturation limit of the soil pore air have been reached. C_{sat} is not equivalent to the concentration at which free product is observed; it is an upper limit for transport of petroleum fractions in cross-media pathways. A similar and related term is residual saturation (RES). When

calculating RBSLs, a value of RES means that the selected risk level (e.g., HI = 1.0) could not be reached or exceeded for the pathway and scenario given the constituents present, regardless of the contaminant concentration. The value of RES is attained at the TPH concentration at which the C_{sat} of the mixture is reached (i.e., each fraction has reached C_{sat}). When calculating the whole TPH RBSL, a value of RES indicates that even if the concentration of each fraction is set equal to C_{sat} for that fraction and pathway, the combined risk associated with each fraction still does not yield a HI of 1.0. It is important to note that C_{sat} is not an appropriate constraint for the direct contact pathway because the exposure is to the contaminated soil and not to a medium to which the soil contamination has been transferred. Although C_{sat} may limit exposure for this pathway, not using C_{sat} to limit exposure adds further conservatism to the risk calculation[7].

3.3 RBSL Calculation Procedures

As stated above, RBSLs for each TPH fraction and each pathway are calculated using standard ASTM RBCA default equations[7]. The fraction-specific fate and transport data are presented in Table 3-1 below, and the toxicity data are presented in Table 3-2 below. The procedure for calculating TPH RBSLs for cross-media pathways based upon summing the risk from each fraction is somewhat more complex[7].

For leaching and volatilization pathways, transport and therefore exposure are maximized at C_{sat} for specific fractions. Using this basis, the HQ for each fraction is calculated as the minimum of two values: (1) the weight percentage of the fraction times the whole TPH RBSL, divided by the fraction RBSL, or (2) C_{sat} for the fraction, divided by the fraction RBSL. The HI is defined as the sum of the HQs for each fraction. Using these calculations, the whole TPH RBSL can be calculated iteratively, under the constraint that the sum of the weight fractions does not exceed 1.0 or unity[7].

For direct exposure routes such as soil ingestion, dermal absorption and particulate inhalation, the exposure is not limited by C_{sat} because intake will continue to increase linearly with soil loading beyond C_{sat}. (Note: The presence of non-aqueous phase liquid (NAPL) in the soil is not an issue in a direct contact pathway because the receptor is already directly exposed to the contaminated soil.) In this case, the HQ for each fraction is defined as the weight percentage of the fraction times the whole TPH RBSL, divided by the fraction RBSL. The sum of all HQs is equal to the HI for the mixture, which must be less than 1.0 to meet the target risk level[7]. The equations used to calculate the TPH fraction RBSLs and the whole TPH RBSL (C_{TPH}) are provided in Appendix B.

Table 3-1: Hydrocarbon Fractions and Associated Properties

TPH Fractions	Solubility (mg/L)	Henry's Constant (dimensionless)	Vapor Pressure (atm)	Log K_{oc} (c/c)	BP (°C)	MW (g/mole)
Aliphatic						
EC5-6	28	33	0.5	2.9	51	81
EC>6-8	4.2	50	0.85	3.6	96	100
EC>8-10	0.33	80	0.0081	4.5	150	130
EC>10-12	0.026	120	7.8E-4[c]	5.4	200	160
EC>12-16	5.9E-4	520	3.5E-5	6.7	260	200
EC>16-21	1.0E-6	4,900	1.7E-6	8.8	320	270
Aromatic						
EC5-7[a]	18	0.23	0.13	1.9	80	78
EC>7-8[b]	520	0.27	0.038	2.4	110	92
EC>8-10	65	0.48	0.0081	3.2	150	120
EC>10-12	25	0.14	7.8E-4	3.4	200	130
EC>12-16	5.8	0.053	3.5E-5	3.7	260	150
EC>16-21	0.51	0.013	1.7E-6	4.2	320	190
EC>21-35	0.0066	6.7E-4	7.9E-9	5.1	340	240

[a] (Benzene)
[b] (Toluene)
[c] (scientific notation, 7.8×10^{-4})
EC = equivalent carbon number
BP = boiling point
MW = molecular weight
Note: Values are based on pure compounds; behavior may differ in complex mixtures.

Table 3-2: TPHCWG Toxicity Fraction-Specific Reference Doses (RfDs) (mg/kg/day)

Carbon Range	Aromatic RfD	Critical Effect	Aliphatic RfD	Critical Effect
EC5-6 EC7-8	0.20 – Oral 0.10 – Inhalation	Hepatotoxicity, Nephrotoxicity	5.0 – Oral 5.0 – Inhalation	Neurotoxicity
EC9-10 EC11-12 EC13-16	0.04 – Oral 0.05 – Inhalation	Decreased body weight	0.1 – Oral 0.3 – Inhalation	Hepatic and hematological changes
EC17-21 EC22-34	0.03	Nephrotoxicity	1.00	Hepatic (foreign body reaction) granuloma

4.0 ANALYTICAL RESULTS

4.1 Analytical Data Summary

A summary of the analytical data for the fifteen primary soil samples, the one duplicate and "background" soil samples (matrix spike/matrix spike duplicate) collected at the FF site is shown in Table 4-1. The approximate locations where the soil samples were collected and their respective sample numbers are shown in Figure 2-1. All soil samples were analyzed for BTEX, PAHs, TPH-GRO and TPH-DRO by EMAX Laboratories, Inc. The composited soils used for TPH-DRO and PAH analyses were also analyzed for TPHCWG aliphatic and aromatic fractions by Lancaster Laboratories under subcontract to OpTech.

4.2 BTEX, PAH and TPH Analysis by Standard Methods

As shown in Table 4-1, some BTEX was detected above the limits determined for the analytical method (i.e., the method detection limit) in most of the samples. However, the highest concentrations of BTEX were detected in sample numbers HP007-01 through HP009-02, collected from the eastern end of the FF at depths between one and three feet bgs. Benzene concentrations ranged from 1300 μg/kg to 31,000 μg/kg. Toluene concentrations ranged from 230 μg/kg to 31,000 μg/kg. Ethylbenzene concentrations ranged from 1,700 μg/kg to 33,000 μg/kg and xylene concentrations ranged from 1520 μg/kg to 92,000 μg/kg.

Several PAHs were also detected in the samples with elevated BTEX levels. Naphthalene was the most prevalent PAH, with concentrations ranging from 2,900 μg/kg, detected in sample number HP007-01, to 23,000 μg/kg, detected in sample number HP009-02. Sample number HP009-02 also contained fluorene at a concentration of 2,200 μg/kg, phenanthrene at a concentration of 1,000 μg/kg and fluoranthrene at a concentration of 1,000 μg/kg. The analytical data included a few PAHs that were identified at concentrations below the method detection limit. These values were estimated using the instrument detection limit and the dilution factor. PAHs were not identified above method detection limits in any of the other samples. However, some variation in method detection limits for PAHs were noted in the samples that did not contain TPH. These variations were attributable to the differences in the moisture content of the samples.

TPH-GRO was detected at concentrations that ranged from less than 1 mg/kg to 3,400 mg/kg. TPH-DRO concentrations ranged from 7.8 mg/kg to 9,800 mg/kg. Sample number HP007-01 contained the highest concentrations of TPH-GRO (3,400 mg/kg) and the highest concentration of TPH-DRO was detected in sample number HP009-02 (9,800 mg/kg). All of the samples collected near the pumping station (i.e., in boring location numbers HP007 through HP009) contained TPH at concentrations that were three or more orders of magnitude above "background" values. The "background" soil sample, number HP001-09, was collected on the western edge of the fuel farm. This "background" soil sample contained no detectable levels of any of the target compounds listed in Table 4-1. All other samples collected away from the pump area, including the samples collected below the tanks, in the vicinity of the filter/separator area (i.e., at boring numbers HP010 and HP011), contained only trace concentrations of petroleum hydrocarbons.

Table 4-1: Analytical Data Summary, Air Force Plant 6 Fuel Farm
TPHCWG Demonstration Project

Field Sample Numbers →	HP001-09[1]	HP002-08	HP003-05	HP004-06	HP005-01	HP005-03	HP006-01[2]	HP006-02
Depth (feet bgs)	9	8	5	6	1	3	1	2
FID reading (highest in ppm)	2051	234	61	1862	283	582	295	1630
Moisture (% by weight)	12.70	15.00	18.40	17.10	20.20	18.20	20.20	16.40
VOCs (ug/kg)								
benzene	0.81	4.5	0.28	3.7	6.1	5.2	38	6.5
toluene	0.23	0.19	5.2	0.57	1.5	1.7	98	6.5
ethylbenzene	4.4	4.5	5.2	2.6	6.3	2.1	51	6.5
xylene	9.21	13.6	15.2	5.6	15.6	13.5	417	19.5
PAHs (ug/kg)[4]								
acenaphthene	380	390	400	400	420	410	400	400
pyrene	380	390	400	400	420	410	400	400
naphthalene	380	390	400	400	420	410	400	400
acenaphthylene	380	390	400	400	420	410	400	400
fluorene	380	390	400	400	420	410	400	400
phenanthrene	380	390	400	400	420	410	400	400
anthracene	380	390	400	400	420	410	400	400
fluoranthene	380	390	400	400	420	410	400	400
benzo(a)anthracene	380	390	400	400	420	410	400	400
chrysene	380	390	400	400	420	410	400	400
benzo(b)fluoranthene	380	390	400	400	420	410	400	400
benzo(k)fluoranthene	380	390	400	400	420	410	400	400
benzo(a)pyrene	380	390	400	400	420	410	400	400
indeno(1,2,3-cd)pyrene	380	390	400	400	420	410	400	400
dibenz(a,h)anthracene	380	390	400	400	420	410	400	400
benzo(g,h,I)perylene	380	390	400	400	420	410	400	400
TPH-GRO (mg/kg)	0.048	0.18	0.21	0.96	1.2	1.0	6.0	1.3
TPH-DRO (mg/kg)	12	9.5	12	7.8	13	7.9	29	12
Total TPH (GRO+DRO) (mg/kg)	12.048	9.68	12.21	8.76	14.2	8.9	35	13.3
Total TPH Fractions (mg/kg)[3]	<234	<243	<252	<245	<257	<248	<257	<245
HYDROCARBON FRACTIONS								
(Dry Weight Data) (mg/kg)								
Aliphatics								
Volatile Range 1	<0.23	<0.24	<0.25	<0.24	<0.25	<0.24	<0.25	<0.24
Volatile Range 2	<0.23	<0.24	<0.25	<0.24	<0.25	<0.24	<0.25	<0.24
>C8 - <=C10	<4.6	<4.7	<4.9	<4.8	<5.0	<4.9	<5.0	<4.8
>C10 - <=C12	<9.2	<9.4	<9.8	<9.7	<10	<9.8	<10	<9.6
>C12 - <=C16	<23	<24	<25	<24	<25	<24	<25	<24
>C16 - <=C21	<23	<24	<25	<24	<25	<24	<25	<24
>C21 - <=C35	<57	<59	<61	<60	<63	<61	<63	<60
Aromatics								
Volatile Range 1	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Volatile Range 2	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
>C8 - <=C10	<4.6	<4.7	<4.9	<4.8	<5.0	<4.9	<5.0	<4.8
>C10 - <=C12	<9.2	<9.4	<9.8	<9.7	<10	<9.8	<10	<9.6
>C12 - <=C16	<23	<24	<25	<24	<25	<24	<25	<24
>C16 - <=C21	<23	<24	<25	<24	<25	<24	<25	<24
>C21 - <=C35	<57	<59	<61	<60	<63	<61	<63	<60
Total TPH Fractions (mg/kg)[3]	<234	<243	<252	<245	<257	<248	<257	<245

Note 1 - "background" soil sample; Note 2 - duplicate soil sample; Note 3 - Total TPH fraction concentrations include values set to 1/2 the detection limit for fractions that were not detected (i.e., for quantities indicated by < in the table)

Note 4 - Nondetects set to method detection limit, which varied from sample to sample due to moisture content

Volatile Range 1 = C5 to C6 aliphatic (total) hydrocarbons; C6 to C7 aromatic hydrocarbons (benzene only)

Volatile Range 2 = >C6 to C8 aliphatic (total minus benzene and toluene) hydrocarbons; >C7 to C8 aromatics (toluene only)

Table 4-1 (cont'd): Analytical Data Summary, Air Force Plant 6 Fuel Farm
TPHCWG Demonstration Project

Field Sample Numbers →	HP006-11[2]	HP007-01	HP008-01	HP008-03	HP009-01	HP009-02	HP010-01	HP010-06	HP011-06
Depth (feet bgs)	2	1	1	3	1	2	1	6	6
FID reading (highest in ppm)	2077	1938	637	>2077	94	>2077	0	350	796
Moisture (% by weight)	15.30	20.50	18.00	15.90	17.10	20.10	18.70	19.60	16.20
VOCs (ug/kg)									
benzene	6.5	29000	28000	1300	31000	30000	5.5	5.6	12
toluene	6.5	13000	2500	230	31000	30000	0.52	5.6	1.6
ethylbenzene	6.5	29000	10000	1700	31000	33000	5.5	5.6	5.2
xylene	19.5	89000	83000	1520	92000	89000	16.5	16.6	15.2
PAHs (ug/kg)[4]									
acenaphthene	400	430	390	390	400	840	400	400	390
pyrene	400	100	190	95	390	880	400	120	390
naphthalene	400	2900	11000	4200	13000	23000	400	400	390
acenaphthylene	400	430	390	390	400	410	400	400	390
fluorene	400	430	1500	580	690	2200	400	400	390
phenanthrene	400	430	270	150	420	1000	400	400	390
anthracene	400	430	390	390	110	310	400	400	390
fluoranthene	400	76	220	120	440	1000	400	120	390
benzo(a)anthracene	400	430	75	390	200	430	400	110	390
chrysene	400	430	65	390	180	440	400	110	390
benzo(b)fluoranthene	400	430	390	390	180	410	400	260	390
benzo(k)fluoranthene	400	430	390	390	74	170	400	86	390
benzo(a)pyrene	400	430	390	390	130	320	400	170	390
indeno(1,2,3-cd)pyrene	400	430	390	390	400	120	400	130	390
dibenz(a,h)anthracene	400	430	390	390	400	410	400	400	390
benzo(g,h,l)perylene	400	430	390	390	51	120	400	100	390
TPH-GRO (mg/kg)	1.3	3400	1200	200	2500	2500	0.083	0.22	0.49
TPH-DRO (mg/kg)	12	3900	7400	4200	4400	9800	12	12	12
Total TPH (GRO+DRO) (mg/kg)	13.3	7300	8600	4400	6900	12300	12.083	12.22	12.49
Total TPH Fractions (mg/kg)[3]	<243	3,228	5,779	2,511	6,523	9,339	<254	<255	<245
HYDROCARBON FRACTIONS									
(Dry Weight Data) (mg/kg)									
Aliphatics									
Volatile Range 1	<0.24	<50	<9.7	<2.4	<9.7	<50	<0.25	<0.25	<0.24
Volatile Range 2	<0.24	<50	13	8.17	54.89	143	<0.25	<0.25	<0.24
>C8 - <=C10	<4.7	670	230	83	540	980	<4.9	<5.0	<4.8
>C10 - <=C12	<9.4	1,400	1,700	660	2,000	2,900	<9.8	<10	<9.5
>C12 - <=C16	<24	660	2,700	1,200	2,500	3,600	<25	<25	<24
>C16 - <=C21	<24	<50	<120	<48	<120	<130	<25	<25	<24
>C21 - <=C35	<59	<130	<300	<120	<300	<310	<62	<62	<60
Aromatics									
Volatile Range 1	<0.006	<1.3	<0.244	<0.059	<0.2	<1.3	<0.006	<0.006	<0.006
Volatile Range 2	<0.006	<1.3	<0.244	<0.059	<0.2	<1.3	<0.006	<0.006	<0.006
>C8 - <=C10	<4.7	38	5.2	<4.8	16	28	<4.9	<5.0	<4.8
>C10 - <=C12	<9.4	180	210	110	350	450	<9.8	<10	<9.5
>C12 - <=C16	<24	95	650	320	780	930	<25	<25	<24
>C16 - <=C21	<24	<25	32	<24	37	30	<25	<25	<24
>C21 - <=C35	<59	<63	<61	<59	<60	<63	<62	<62	<60
Total TPH Fractions (mg/kg)[3]	<243	3,228	5,779	2,511	6,523	9,339	<254	<255	<245

Note 1 - "background" soil sample; Note 2 - duplicate soil sample; Note 3 - Total TPH fraction concentrations include values set to 1/2 the detection limit for fractions that were not detected (i.e., for quantities indicated by < in the table)

Note 4 - Nondetects set to method detection limit, which varied from sample to sample due to moisture content

Volatile Range 1 = C5 to C6 aliphatic (total) hydrocarbons; C6 to C7 aromatic hydrocarbons (benzene only)

Volatile Range 2 = >C6 to C8 aliphatic (total minus benzene and toluene) hydrocarbons; >C7 to C8 aromatics (toluene only)

4.3 TPH Aliphatic and Aromatic Fractions by the Direct Method

Soil samples were analyzed for aliphatic and aromatic petroleum fractions, as shown in Table 4-1. The highest concentrations of petroleum hydrocarbons were detected in the >C12-C16 aliphatic fraction. These results are consistent with the TPH-DRO analytical data, which indicate that much of the detectable TPH was in the DRO range. The sum of the petroleum fraction concentrations, however, is significantly less than the sum of the TPH-GRO and DRO concentrations for those samples containing detectable levels of petroleum hydrocarbons. Measured concentrations of TPH fractions (i.e., with all non-detects set to one-half the detection limit) ranged from 42.9 percent to 89.8 percent of the total TPH (GRO + DRO), with an overall average of 67 percent for the five samples containing detectable TPH concentrations. Although better agreement between total TPH and TPH fraction concentrations was anticipated, the differences are probably attributable more to the sample collection methodology than to differences between the analytical laboratories. TPH-GRO and BTEX concentrations were measured using grab samples taken with Encore® samplers from the sample interval. The TPH-DRO, PAH and TPH fractional analyses were performed on the same sample interval after the soil was carefully composited.

4.4 Comparison of Analytical Results with Field Screening Data

The field screening data obtained by performing a field screening analysis of soil samples using a FID are shown in Table 4-1. As shown in the table, the FID readings correlated poorly with the concentration of petroleum hydrocarbons in site soils. Although three of the five samples that contained high concentrations of petroleum hydrocarbons also had high FID readings, four of the twelve samples with "background" concentrations of petroleum hydrocarbons also had high FID readings. Daily calibrations with methane and functional tests of the FID indicated that the instrument was operating properly. Although frequent aircraft operations in the vicinity (i.e., on the nearby taxiways and runway) were noted by the field sampling team during soil coring/sampling activities, FID readings were 0.0 ppm under ambient conditions and remained at 0.0 ppm until soil cores were screened.

Due to the screening method, FID readings were taken while the soil was still encased in the tube. Encore® samples were taken when the tube was first opened to the ambient air. TPH fractional analyses were performed on soil that had been composited in a stainless steel bowl in the open air, allowing for volatilization to occur.

4.5 Fingerprint Analysis of TPH Fractions

The analytical data described above were subjected to a "fingerprint" analysis as shown in Table 4-2. This "fingerprint" analysis summarizes the weight fraction of aliphatic and aromatic compounds that were detected in each sample. This analysis excluded those samples that contained no detectable concentrations of petroleum hydrocarbons (i.e., sample numbers HP001-09 through HP006-11 and sample numbers HP010-01 through HP011-06). For all five samples with detectable levels of petroleum compounds, the weight percent of aliphatic fractions ranged from 80.66% to 88.67%. The weight percent of aromatic fractions ranged from 11.33% to 19.34%. Further analysis indicated generally good agreement between the weight fractions of the heavier aliphatic and aromatic hydrocarbons and the weight percent of DRO (83.48% vs. 75.68%). However, agreement between the weight fractions of the lighter aliphatic and aromatic hydrocarbons and the weight percent of GRO is poor (6.27% vs. 24.3%).

The generally good agreement between the heavier aliphatic and aromatic weight fractions and the weight fraction of TPH-DRO reported by the analytical laboratories is consistent with the sampling methodology (i.e., split sampling). However, the analysis of grab versus composite samples from the same core segments by the two analytical laboratories for the volatile hydrocarbons most likely accounts for the poor agreement between the lighter aliphatic and aromatic weight fractions and the weight fraction TPH-GRO. Although this limited analysis is not conclusive, it does indicate that the petroleum contamination detected in the split soil samples was of similar composition (i.e., medium to heavy aliphatic and aromatic compounds). This analysis further indicates that comparisons between TPH-DRO and TPH-GRO concentrations and concentrations of TPH fractions should be made only when the analysis is performed on soil sampled using the same collection technique. It is also evident from this analysis that the petroleum contamination detected in site soils at the FF is inconsistent with the weathered fuel "fingerprint" (i.e., low concentrations of TPH-GRO and little or no BTEX) that was expected at a facility that has been inactive for more than eight years.

4.6 Field Sampling and Laboratory Quality Control

Field quality control (QC) measures included the collection of a rinsate blank, a deionized water blank and a laboratory-prepared trip blank that accompanied the sample bottles from the laboratory to the field and from the field to the laboratory. These water samples were analyzed for BTEX. No BTEX was detected above method detection limits in any of these field QC samples.

Laboratory QC measures included the collection and submission of one "blind" field duplicate and two matrix spike/matrix spike duplicate samples collected from a "background" sampling location. Internal laboratory QC measures included the preparation and analysis of laboratory control samples and laboratory control sample duplicates to assess the degree to which analytical data met limits of quantitation and relative percent difference goals specified for each method. Poor surrogate recoveries were observed for some soil samples indicating a significant matrix effect. Poor surrogate recoveries for a few soil samples were also attributable to the dilution needed to perform the analysis. However, very good agreement was obtained between the primary and duplicate soil samples. Consequently, the overall quality assurance objectives for the project were met.

Table 4-2: TPHCWG Demonstration, AF Plant 6 Fuel Farm
"Fingerprint" Analysis

Sample Numbers →	HP007-01	HP008-01	HP008-03	HP009-01	HP009-02
TPH Fractions ↓	Wt. Frac. mg/kg/mg/kg	Wt. Frac. mg/kg/mg/kg	Wt. Frac. mg/kg/mg/kg	Wt. Frac. mg/kg/mg/kg	Wt. Frac. mg/kg/mg/kg
>C5-C6 Aliphatics	7.63E-03	8.36E-04	4.76E-04	7.37E-04	2.63E-03
>C6-C8 Aliphatics	7.63E-03	2.24E-03	3.24E-03	8.34E-03	1.50E-02
>C8-C10 Aliphatics	2.04E-01	3.96E-02	3.29E-02	8.20E-02	1.03E-01
>C10-C12 Aliphatics	4.27E-01	2.93E-01	2.62E-01	3.04E-01	3.05E-01
>C12-C16 Aliphatics	2.01E-01	4.65E-01	4.76E-01	3.80E-01	3.79E-01
>C16-C21 Aliphatics	7.63E-03	1.03E-02	9.53E-03	9.12E-03	6.84E-03
>C5-C7 Aromatics	1.98E-04	2.10E-05	1.19E-05	1.52E-05	6.84E-05
>C7-C8 Aromatics	1.98E-04	2.10E-05	1.19E-05	1.52E-05	6.84E-05
>C8-C10 Aromatics	1.16E-02	8.96E-04	9.53E-04	2.43E-03	2.95E-03
>C10-C12 Aromatics	5.49E-02	3.62E-02	4.37E-02	5.32E-02	4.73E-02
>C12-C16 Aromatics	2.90E-02	1.12E-01	1.27E-01	1.18E-01	9.78E-02
>C16-C21 Aromatics	3.81E-03	5.51E-03	4.76E-03	5.62E-03	3.16E-03
>C21-C35 Aromatics	9.61E-03	5.26E-03	1.17E-02	4.56E-03	3.31E-03
Total[1]	9.65E-01	9.71E-01	9.72E-01	9.68E-01	9.66E-01
Aliphatics	88.67%	83.53%	80.66%	80.96%	83.98%
Aromatics	11.33%	16.47%	19.34%	19.04%	16.02%
>C10-C12 Aliphatics	44.30	30.20	26.90	31.40	31.60
>C12-C16 Aliphatics	20.90	47.90	49.00	39.20	39.20
>C16-C21 Aliphatics	0.79	1.06	0.98	0.94	0.71
>C12-C16 Aromatics	3.0032	11.5334	13.0595	12.2392	10.1265
>C16-C21 Aromatics	0.3952	0.5678	0.4897	0.5806	0.3267
% of Total Fractions	69.39	91.26	90.43	84.36	81.96
DRO (% of Total TPH)	53.4	86	95.5	63.8	79.7
>C5-C6 Aliphatics	0.79	0.09	0.05	0.08	0.27
>C6-C8 Aliphatics	0.79	0.23	0.33	0.86	1.56
>C5-C7 Aromatics	0.0205	0.0022	0.0012	0.0016	0.0071
>C7-C8 Aromatics	0.0205	0.0022	0.0012	0.0016	0.0071
>C8-C10 Aromatics	1.2013	0.0923	0.0979	0.2511	0.3049
>C10-C12 Aromatics	5.6903	3.7262	4.4892	5.492	4.8999
% of Total Fractions	8.5126	4.1429	4.9695	6.6863	7.049
GRO (% of Total TPH)	46.6	13.9	4.5	36.2	20.3

[1]Note: Total includes weight fractions set to 1/2 detection limit values

5.0 TIER 1 RBSLs CALCULATED FROM TPH FRACTIONAL ANALYSIS DATA

5.1 RBSLs for Commercial/Industrial Exposure Scenario

Commercial/Industrial Tier 1 RBSLs are presented in the odd numbered Tables A-3 through A-35 located in Appendix A. For the direct soil exposure pathways (i.e., surface soil

ingestion, surface soil dermal contact, and fugitive dust inhalation), all Tier 1 RBSLs are well above the TPH fraction specific and total TPH concentrations detected in FF soils. Consequently, for these exposure pathways, the concentrations of TPH detected in the aliphatic and aromatic fractions and the total TPH detected in FF soils do not pose a significant risk under the commercial/industrial exposure scenario.

Among the indirect soil exposure pathways, the subsurface soil indoor vapor inhalation pathway consistently contained the lowest total TPH RBSLs, ranging from 99 mg/kg to 359 mg/kg. For this pathway all five samples with detectable concentrations of TPH fractions exceeded their respective total TPH RBSLs, as shown in Table 5-1. Much of the risk is attributable to the high concentrations of TPH in the EC>8-EC10, EC>10-EC12 and EC>12-EC16 aliphatic fractions. However, the risk is also attributable to high concentrations of TPH in the EC>5-EC7 and the EC>10-EC12 aromatic fractions. The risks for direct and indirect exposure for groundwater pathways were not evaluated because groundwater was not sampled as part of this demonstration project.

A number of assumptions are used to calculate the RBSL for the subsurface soil indoor vapor inhalation pathway. For example, the calculation assumes there is a constant chemical concentration in subsurface soils, that there is no loss of chemical as it diffuses towards the ground surface, that steady-state vapor- and liquid-phase diffusion occurs through the vadose zone and foundation cracks, and that one percent of the building foundation surface area is cracked[2]. Added to these assumptions is the considerable distance between the TPH contamination in soils at the FF and the nearest occupied building (a distance of over 50 yards). Consequently, the subsurface soil indoor vapor inhalation pathway provides an extremely conservative estimate of the actual risk to commercial/industrial receptors.

Table 5-1: RBSLs for Commercial Exposure Scenario
AF Plant 6 Fuel Farm

	aliphatics (mg/kg)						aromatics (mg/kg)							Total TPH	Total TPH RBSL*
Sample #	C>5-C6	C>6-C8	C>8-C10	C>10-C12	C>12-C16	C>16-C21	C>5-C7	C>7-C8	C>8-C10	C>10-C12	C>12-C16	C>16-C21	C>21-C35	(mg/kg)	(mg/kg)
HP001-09[a]	0.115	0.115	2.3	4.6	11.5	11.5	0.003	0.003	2.3	4.6	11.5	11.5	28.5	89	503
HP002-08	0.12	0.12	2.3	4.7	12	12	0.003	0.003	2.3	4.7	12	12	29.5	92	510
HP003-05	0.125	0.125	2.45	4.9	12.5	12.5	0.003	0.003	2.45	4.9	12.5	12.5	30.5	95	510
HP004-06	0.12	0.12	2.4	4.85	12	12	0.003	0.003	2.4	4.9	12	12	30	93	504
HP005-01	0.125	0.125	2.5	5	12.5	12.5	0.003	0.003	2.5	5	12.5	12.5	31.5	97	507
HP005-03	0.12	0.12	2.45	4.9	12	12	0.003	0.003	2.45	4.9	12	12	30.5	93	500
HP006-01	0.125	0.125	2.5	5	12.5	12.5	0.003	0.003	2.5	5	12.5	12.5	31.5	97	507
HP006-02	0.12	0.12	2.4	4.8	12	12	0.003	0.003	2.4	4.8	12	12	30	93	505
HP006-11[b]	0.12	0.12	2.35	4.7	12	12	0.003	0.003	2.35	4.7	12	12	29.5	92	510
HP007-01	25	25	**670**	**1400**	660	25	**0.65**	0.65	38	180	95	12.5	31.5	**3163**	99
HP008-01	4.85	13	**230**	**1700**	**2700**	60	0.122	0.122	5.2	210	650	32	30.5	**5636**	313
HP008-03	1.2	8.17	**83**	**660**	**1200**	24	0.0295	0.0295	2.4	110	320	12	29.5	**2450**	359
HP009-01	4.85	54.89	**540**	**2000**	**2500**	60	0.1	0.1	16	**350**	780	37	30	**6373**	205
HP009-02	25	143	**980**	**2900**	**3600**	65	**0.65**	0.65	28	**450**	930	30	31.5	**9184**	173
HP010-01	0.125	0.125	2.45	4.9	12.5	12.5	0.003	0.003	2.45	4.9	12.5	12.5	31	96	512
HP010-06	0.125	0.125	2.5	5	12.5	12.5	0.003	0.003	2.5	5	12.5	12.5	31	96	505
HP011-06	0.12	0.12	2.4	4.75	12	12	0.003	0.003	2.4	4.75	12	12	30	93	506
RBSL*	61	150	34	180	810	No RfC	0.35	34	56	300	1,600	No RfC	No RfC		

* - Subsurface soil indoor vapor inhalation (mg/kg)
[a] - background soil sample
[b] - duplicate soil sample
Note: values in bold exceed their respective RBSLs

Because the risk estimate for the subsurface soil indoor vapor inhalation pathway is highly conservative, an additional risk assessment was performed for the subsurface soil outdoor vapor inhalation pathway. For this pathway the total TPH RBSLs range from 62,500

mg/kg to 967,000 mg/kg, as shown in Table 5-2. None of the five soil samples that contained detectable levels of petroleum contamination (i.e., HP007-01 and HP009-02) exceeded their respective total TPH RBSLs for this pathway. It is evident from this dual pathway analysis that the high concentrations of aromatic hydrocarbons in the lighter fractions are driving the risk posed by the petroleum contamination in FF soils. As shown in Table 4-1 and in the even number Tables A-20 through A-28 in Appendix A, this risk result is mainly attributable to the high concentrations of benzene in these samples.

Table 5-2: RBSLs for Commercial Exposure Scenario
AF Plant 6 Fuel Farm

	aliphatics (mg/kg)						*aromatics (mg/kg)*							Total TPH (mg/kg)	Total TPH RBSL* (mg/kg)
Sample #	C>5-C6	C>6-C8	C>8-C10	C>10-C12	C>12-C16	C>16-C21	C>5-C7	C>7-C8	C>8-C10	C>10-C12	C>12-C16	C>16-C21	C>21-C35		
HP001-09[a]	0.115	0.115	2.3	4.6	11.5	11.5	0.003	0.003	2.3	4.6	11.5	11.5	28.5	89	333,000
HP002-08	0.12	0.12	2.3	4.7	12	12	0.003	0.003	2.3	4.7	12	12	29.5	92	343,000
HP003-05	0.125	0.125	2.45	4.9	12.5	12.5	0.003	0.003	2.45	4.9	12.5	12.5	30.5	95	353,000
HP004-06	0.12	0.12	2.4	4.85	12	12	0.003	0.003	2.4	4.9	12	12	30	93	346,000
HP005-01	0.125	0.125	2.5	5	12.5	12.5	0.003	0.003	2.5	5	12.5	12.5	31.5	97	358,000
HP005-03	0.12	0.12	2.45	4.9	12	12	0.003	0.003	2.45	4.9	12	12	30.5	93	349,000
HP006-01	0.125	0.125	2.5	5	12.5	12.5	0.003	0.003	2.5	5	12.5	12.5	31.5	97	358,000
HP006-02	0.12	0.12	2.4	4.8	12	12	0.003	0.003	2.4	4.8	12	12	30	93	346,000
HP006-11[b]	0.12	0.12	2.35	4.7	12	12	0.003	0.003	2.35	4.7	12	12	29.5	92	343,000
HP007-01	25	25	670	1400	660	25	0.65	0.65	38	180	95	12.5	31.5	3163	62,500
HP008-01	4.85	13	230	1700	2700	60	0.122	0.122	5.2	210	650	32	30.5	5636	640,000
HP008-03	1.2	8.17	83	660	1200	24	0.0295	0.0295	2.4	110	320	12	29.5	2450	967,000
HP009-01	4.85	54.89	540	2000	2500	60	0.1	0.1	16	350	780	37	30	6373	705,000
HP009-02	25	143	980	2900	3600	65	0.65	0.65	28	450	930	30	31.5	9184	195,000
HP010-01	0.125	0.125	2.45	4.9	12.5	12.5	0.003	0.003	2.45	4.9	12.5	12.5	31	96	355,000
HP010-06	0.125	0.125	2.5	5	12.5	12.5	0.003	0.003	2.5	5	12.5	12.5	31	96	356,000
HP011-06	0.12	0.12	2.4	4.75	12	12	0.003	0.003	2.4	4.75	12	12	30	93	345,000
RBSL*	4100	9800	2300	12000	54,000	No RfC	23	2300	3700	20,000	110,000	No RfC	No RfC		

* - Subsurface soil outdoor vapor inhalation (mg/kg)
[a] - background soil sample
[b] - duplicate soil sample
Note: values in bold exceed their respective RBSLs

5.2 State of Georgia Cleanup Standards for Hydrocarbon Contaminated Soil

Presently the State of Georgia has not established cleanup standards for hydrocarbon contaminated soil on the basis of total TPH, TPH-GRO, or TPH-DRO. Current standards set cleanup levels for BTEX and PAHs as shown in Table 5-3 below[8]:

Table 5-3: Georgia Cleanup Standards for Hydrocarbon Contaminated Soil

VOCs	**Cleanup Level**
Benzene	5 µg/kg
Toluene	400 µg/kg
Ethylbenzene	370 µg/kg
Xylenes (total)	20,000 µg/kg
PAHs	
Acenaphthene	N/A
Anthracene	N/A
Benzo(a)anthracene	660 µg/kg
Benzo(a)pyrene	660 µg/kg
Benzo(b)fluoranthene	660 µg/kg
Benzo(g,h,I)perylene	N/A
Benzo(k)fluoranthene	660 µg/kg
Chrysene	660 µg/kg
Dibenz(a,h)anthracene	660 µg/kg
Fluoranthene	N/A
Fluorene	N/A
Indeno(1,2,3-c,d)pyrene	660 µg/kg
Naphthalene	N/A
Phenanthrene	N/A
Pyrene	N/A

Three of the soil samples collected for this study contain total xylenes and toluene at concentrations above the cleanup standard. Four samples have ethylbenzene concentrations above the standard and all but four of the samples contain benzene above the cleanup standard. All five of the soil samples that have TPH at concentrations that pose risk to commercial/industrial receptors for the subsurface soil indoor vapor inhalation pathway also contain benzene at concentrations ranging from nearly two orders of magnitude to more than four orders of magnitude above the cleanup standard.

6.0 LESSONS LEARNED

- The same soil sampling technique is necessary to obtain comparable total TPH, TPH-GRO, TPH-DRO, BTEX and TPH fractional analysis data. Whenever possible, the same laboratory should perform all required analyses.
- Direct push sampling generally provides insufficient soil volume from a given sample interval to perform all laboratory analyses required by the prime contractor (i.e., TPH-GRO, TPH-DRO, BTEX and PAHs) as well as the TPH fractional analysis needed for TPHCWG demonstration purposes. Larger down hole sampling equipment (e.g., hollow-stem auger drilling rig with three-inch diameter split spoons) is preferable at TPHCWG demonstration sites where soil samples are split with another contractor.
- Compositing soil samples in a stainless steel bowl may lead to significant volatilization of lighter TPH constituents. The practicality of compositing soil in a sealed plastic bag should

be considered. Some soil types (e.g., clay, saprolite) may require extensive "chopping" with the spoon, making this technique difficult to implement.

- Candidate sites for demonstration of the TPHCWG approach should be located in states that apply cleanup criteria based upon TPH concentrations (i.e., TPH-GRO and TPH-DRO), not in states that already apply a form of risk-based cleanup criteria.

7.0 CONCLUSIONS AND RECOMMENDATIONS

The petroleum contamination detected in subsurface soil samples collected from the FF site contained high concentrations of BTEX and TPH-GRO. These findings are inconsistent with the predominately heavy TPH fractions that are normally detected in soils containing weathered petroleum products. Only one of the samples with elevated levels of TPH was found to contain predominately diesel range fractions (sample number HP008-03). The TPH mixture in the other samples with elevated levels of TPH included gasoline range fractions in amounts varying from about 14 percent to over 46 percent of the total TPH. The concentration of BTEX in these four samples was also proportionally higher (by more than an order of magnitude) than the BTEX concentration detected in sample number HP008-03. It is interesting to note that this sample was also collected at a lower depth than the other samples that had high TPH and BTEX concentrations. Additionally, groundwater was encountered at a depth of 2.5 feet at sampling location numbers HP007 and HP009, but groundwater was not encountered at sampling location number HP008, despite their close proximity.

None of the soil samples collected on the western edge of the FF, between the tanks, or south of the tanks were found to contain petroleum hydrocarbons at concentrations that were significantly above their method detection limits. This result was contrary to the preliminary soil sampling data obtained in 1997 and to the field screening measurements recorded by the FID during the field sampling activities. The high concentrations of TPH-GRO and BTEX detected in soil samples collected at the eastern edge of the FF in the vicinity of the fuel transfer pumps were also contrary to pre-sampling expectations. (Note: The TPH data obtained from the preliminary site characterization survey performed in 1997 by LMAS included only trace concentrations of xylene, indicating the FF was not a fresh fuel spill site). The analytical data shown in Table 4-1 indicate that the petroleum contamination detected in the soil extracted from the eastern edge of the FF is relatively fresh product.

Among the direct and indirect soil exposure pathways, the subsurface soil indoor vapor inhalation pathway consistently contained the lowest total TPH RBSLs, ranging from 99 mg/kg to 359 mg/kg. For this pathway all five samples with detectable concentrations of TPH fractions exceeded their respective total TPH RBSLs. The risk is attributable to the high concentrations of TPH in the EC>8-EC10, EC>10-EC12 and EC>12-EC16 aliphatic fractions and to the high concentrations of TPH in the EC>5-EC7 and the EC>10-EC12 aromatic fractions. Because petroleum fractions indicative of fresh product are present in the soil, the risk estimate is higher than expected based upon the TPH concentrations detected in the eight samples collected in 1997.

All five samples collected near the pumps located at the eastern edge of the FF contained BTEX at concentrations well above the State of Georgia's cleanup standards for hydrocarbon contaminated soil. Both TPH-GRO and BTEX concentrations measured in the soil are much higher than the levels found at other demonstration sites contaminated with weathered petroleum compounds[9,10,11,12]. Consequently, the petroleum contamination found in the soil at the eastern edge of the FF is probably not site related. Benzene poses the greatest

risk at this site. Its concentration in FF soils is more than three orders of magnitude above the cleanup standard. Further investigation is needed to characterize the petroleum contamination and to determine its source(s). However, additional sampling and analysis activities to demonstrate the TPHCWG approach at this site is not recommended. The petroleum hydrocarbon contamination detected in FF soils is not sufficiently weathered to effectively implement the TPHCWG approach at this site.

8.0 REFERENCES

1. EPA "Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual" (EPA/540/1-89/002), December 1989.
2. American Society for Testing and Materials (ASTM), "Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites", Designation: E 1739 – 95, 1995
3. "Naval Air Station Fuel Farm RCRA Facility Investigation Work Plan, U.S. Air Force Plant No. 6, Marietta, Georgia", Revision 1, May 2000. Prepared by IT Corporation under contract number DACA21-96-D-0018, Task Order 0002 for Lockheed Martin Corporation.
4. OpTech "Site Specific Work Plan, Total Petroleum Hydrocarbon Criteria Working Group Demonstration, Naval Air Station Fuel Farm, U.S. Air Force Plant Number 6, Marietta, Georgia", July 2000.
5. IT, 1998, "Health and Safety Plan U.S. Air Force Plant No. 6, Marietta, Georgia".
6. Chemical Engineers' Handbook, Perry & Chilton, fifth edition, pages 4-64 & 4-65, McGraw-Hill Publishing Company, 1973.
7. RETEC (Remediation Technologies, Inc.), "TPH Criteria Working Group Field Demonstration", MCAS El Toro, California, June 17, 1998.
8. Association for the Environmental Health of Soils' (AEHS's) "2000 Survey of States' Soil and Groundwater Cleanup Standards", February 2001 @http://www.aehs.com.
9. "TPH Criteria Working Group Demonstration Field Sampling Report: Marine Corps Air Station, El Toro, CA", AFRL-HE-WP-TR-1999-0028, October 1998.
10. "TPH Criteria Working Group Field Demonstration Site Report: Robins Air Force Base, Warner-Robbins, GA", AFRL-HE-WP-TR-1999-0212, October 1998.
11. "TPH Criteria Working Group Field Demonstration: Harrier Jet Crash Site, Fairborn, OH", AFRL-HE-WP-TR-1999-0026, October 1998.
12. "Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) Field Demonstration Report: Elmendorf Air Force Base, Alaska", AFRL-HE-WP-TR-2001-0118.

APPENDIX A

TPH FRACTION RBSLs
AND ASSOCIATED COMPOSITION DATA
FOR COMMERCIAL/INDUSTRIAL
EXPOSURE SCENARIO

Table A-1: Risk Spreadsheet

EPA RISK SPREADSHEET
Exposure Assumptions

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP001-09

Parameter	Chronic	Cancer	Units
Soil Ingestion	4.89E-07	1.75E-07	1/d
Soil Dermal Contact	1.55E-05	5.52E-08	1/d
Air Inhalation (outdoor)	1.96E-01	6.99E-02	m^3/kg-d
Air Inhalation (indoor)	1.96E-01	6.99E-02	m^3/kg-d
Drinking Water Ingestion	9.78E-03	3.49E-03	L/kg-d

Exposure Parameters for

Pathways:	Inhalation	Dermal Contact	etc...		
Scenario:	Future	Current			
Exposed Population:	Commercial	Commercial Receptor			
Variable	Subchronic Hazard Index Calculations [S = Subchronic	Chronic Hazard Index Calculations C = Chronic	Excess Lifetime Cancer Risk Calculations CA = Cancer]	Units	Notes & References
GENERAL INFO:					
Age	6 to 30	6 to 30	6 to 30	years	
Bodyweight	70	70	70	kg	
INGESTION OF SOIL (IS):					
Ingestion Rate (IR)	50	50	50	mg soil/day	
Conversion Factor (CF)	1.00E-06	1.00E-06	1.00E-06	kg/mg	
Fraction Ingested (FI)	1	1	1	unitless	
Exposure Frequency (EF)	250	250	250	days/year	
Exposure Duration (ED)	25	25	25	years	
Averaging Time (AT)	25	25	70	years	
DERMAL CONTACT WITH SOIL/SEDIMENT (DC):					
Conversion Factor (CF)	1.00E-06	1.00E-06	1.00E-06	kg/mg	
Skin Surface Area (SA)	3160	3160	3160	cm^2/day	Assumes 1 day
Head					
Trunk					
Upper Extremities					
Arms					
Upper Arms					
Forearms					
Hands					
Lower Extremities					
Legs					
Thighs					
Lower Legs					
Feet					
Soil Adherence Factor (SAF)	0.5	0.5	0.5	mg/cm^2	
Head					
Trunk					
Upper Extremities					
Arms					
Upper Arms					
Forearms					
Hands					
Lower Extremities					
Legs					
Thighs					
Lower Legs					
Feet					
Absorption Factor (AF)				unitless	Note: Absorption is incorporated in RBSL calculation on the exposure assumptions page.
Exposure Frequency (EF)	250	250	250	days/year	
Exposure Duration (ED)	25	25	25	years	
Averaging Time (AT)	25	25	70	years	
INHALATION OF PARTICULATES/VAPORS (I):					
Inhalation rate (outdoor) (INR)	20	20	20	m^3/day	
Exposure Frequency (EF)	250	250	250	days/year	
Exposure Duration (ED)	25	25	25	years	
Averaging Time (AT)	25	25	70	years	
INHALATION OF VAPORS (Indoor Air) (IA):					
Inhalation rate (indoor) (IHR)	20	20	20	m^3/day	
Exposure Frequency (EF)	250	250	250	days/year	
Exposure Duration (ED)	25	25	25	years	
Averaging Time (AT)	25	25	70	years	
INGESTION OF DRINKING WATER OR GROUNDWATER (DW):					
Ingestion Rate (IR)	1	1	1	liters/day	
Exposure Frequency (EF)	250	250	250	days/year	
Exposure Duration (ED)	25	25	25	years	
Averaging Time (AT)	25	25	70	years	

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-2 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP001-09

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.00081	0.00081	9.15E-04	1.17E-05	2.26E-03
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.38	0.19	2.15E-01	9.41E-04	1.81E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.38	0.19	2.15E-01	8.52E-04	1.64E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.38	0.19	2.15E-01	8.52E-04	1.64E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.38	0.19	2.15E-01	8.52E-04	1.64E-01
218-01-9	Chrysene	2.28E+02	<	0.38	0.19	2.15E-01	9.41E-04	1.81E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.38	0.19	2.15E-01	7.72E-04	1.49E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.38	0.19	2.15E-01	7.78E-04	1.50E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.23	0.115	1.30E-01	1.60E-03	3.09E-01
	C>6-C8 aliphatics	1.00E+02	<	0.23	0.115	1.30E-01	1.30E-03	2.50E-01
	C>8-C10 aliphatics	1.30E+02	<	4.6	2.3	2.60E+00	2.00E-02	3.85E+00
	C>10-C12 aliphatics	1.60E+02	<	9.2	4.6	5.20E+00	3.25E-02	6.25E+00
	C>12-C16 aliphatics	2.00E+02	<	23	11.5	1.30E+01	6.49E-02	1.25E+01
	C >16-C21aliphatics	2.70E+02	<	23	11.5	1.30E+01	4.81E-02	9.27E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.39E-03	4.34E-05	8.37E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.39E-03	3.68E-05	7.09E-03
	C >8 - C10 aromatics	1.20E+02	<	4.6	2.3	2.60E+00	2.16E-02	4.17E+00
	C>10-C12 aromatics	1.30E+02	<	9.2	4.6	5.20E+00	4.00E-02	7.70E+00
	C>12-C16 aromatics	1.50E+02	<	23	11.5	1.30E+01	8.66E-02	1.67E+01
	C>16-C21 aromatics	1.90E+02	<	23	11.5	1.30E+01	6.84E-02	1.32E+01
	C>21-C35 aromatics	2.40E+02	<	57	28.5	3.22E+01	1.34E-01	2.58E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	30.13	100	
aromatics	58.406		
Total	88.536		

(LOCATION): HP001-09
Commercial Receptor

Table A-3:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{sat} TPH fractions (I) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)										
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.3E-04	3.5E-03	8.4E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.6E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.2E-02	1.2E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.2E-02	2.3E-02	2.3E-02	4.2E-02	3.5E-04	2.4E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.4E-05	1.5E-03	1.5E-03	3.0E-03	7.4E-01	1.6E-03	4.8E-01	4.9E-02	2.5E-01	3.4E+00	3.7E-04
>7-8 Aromatics	3.4E-05	7.6E-06	7.6E-06	6.8E-05	1.3E-02	9.2E-06	4.9E-03	4.9E-04	4.6E-04	2.4E-02	9.4E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.7E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.2E-02	5.8E-02	5.8E-02	2.1E-01	1.3E-02	6.2E-02	3.1E-02	8.6E-02	3.4E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.1E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

		(mg/kg)	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/L)**	**(mg/L)**
Total TPH (mg/kg)		**9.11E+04**	**5.77E+03**	**5.07E+11**	**5.01E+08**	**5.29E+03**	**3.33E+05**	**5.03E+02**	**8.25E+03**	**8.68E+08**	**9.11E+00**
RBSL(C_{TPH}) (mg/kg)		**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**300000**	**500**	**8000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-4 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP002-08

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.0045	0.0045	4.90E-03	6.28E-05	1.21E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.39	0.195	2.12E-01	9.31E-04	1.80E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.39	0.195	2.12E-01	8.43E-04	1.62E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.39	0.195	2.12E-01	8.43E-04	1.62E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.39	0.195	2.12E-01	8.43E-04	1.62E-01
218-01-9	Chrysene	2.28E+02	<	0.39	0.195	2.12E-01	9.31E-04	1.80E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.39	0.195	2.12E-01	7.64E-04	1.47E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.39	0.195	2.12E-01	7.69E-04	1.48E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.24	0.12	1.31E-01	1.61E-03	3.11E-01
	C>6-C8 aliphatics	1.00E+02	<	0.24	0.12	1.31E-01	1.31E-03	2.52E-01
	C>8-C10 aliphatics	1.30E+02	<	4.7	2.35	2.56E+00	1.97E-02	3.79E+00
	C>10-C12 aliphatics	1.60E+02	<	9.4	4.7	5.12E+00	3.20E-02	6.17E+00
	C>12-C16 aliphatics	2.00E+02	<	24	12	1.31E+01	6.53E-02	1.26E+01
	C >16-C21aliphatics	2.70E+02	<	24	12	1.31E+01	4.84E-02	9.33E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.27E-03	4.19E-05	8.07E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.27E-03	3.55E-05	6.84E-03
	C >8 - C10 aromatics	1.20E+02	<	4.7	2.35	2.56E+00	2.13E-02	4.11E+00
	C>10-C12 aromatics	1.30E+02	<	9.4	4.7	5.12E+00	3.94E-02	7.59E+00
	C>12-C16 aromatics	1.50E+02	<	24	12	1.31E+01	8.71E-02	1.68E+01
	C>16-C21 aromatics	1.90E+02	<	24	12	1.31E+01	6.88E-02	1.33E+01
	C>21-C35 aromatics	2.40E+02	<	59	29.5	3.21E+01	1.34E-01	2.58E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	31.29	100	
aromatics	60.556		
Total	91.846		

(LOCATION): HP002-08
Commercial Receptor

Table A-5:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	$C_{i,sat}$ TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)										
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.4E-04	3.5E-03	8.6E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.1E-02	1.1E-02	2.0E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.1E-02	2.3E-02	2.3E-02	4.1E-02	3.5E-04	2.3E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	6.0E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.3E-05	1.5E-03	1.5E-03	2.9E-03	7.4E-01	1.5E-03	4.8E-01	4.8E-02	2.4E-01	3.4E+00	3.6E-04
>7-8 Aromatics	3.3E-05	7.3E-06	7.3E-06	6.5E-05	1.3E-02	8.9E-06	4.8E-03	4.8E-04	4.5E-04	2.4E-02	9.1E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.7E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.1E-02	5.7E-02	5.7E-02	2.0E-01	1.3E-02	6.1E-02	3.1E-02	8.6E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.5E-01	1.5E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.2E-02	1.2E-01	2.5E-04	2.4E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		9.12E+04	5.77E+03	5.09E+11	5.01E+08	5.30E+03	3.43E+05	5.10E+02	8.43E+03	8.68E+08	9.24E+00
RBSL(C_{TPH}) (mg/kg)		90000	6000	5E+11	>Csat	5000	300000	500	8000	900000000	9

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-6 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP003-05

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.00028	0.00028	2.93E-04	3.76E-06	7.25E-04
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.4	0.2	2.10E-01	9.19E-04	1.77E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.4	0.2	2.10E-01	8.31E-04	1.60E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.4	0.2	2.10E-01	8.31E-04	1.60E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.4	0.2	2.10E-01	8.31E-04	1.60E-01
218-01-9	Chrysene	2.28E+02	<	0.4	0.2	2.10E-01	9.19E-04	1.77E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	2.10E-01	7.54E-04	1.45E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.4	0.2	2.10E-01	7.59E-04	1.46E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.25	0.125	1.31E-01	1.62E-03	3.11E-01
	C>6-C8 aliphatics	1.00E+02	<	0.25	0.125	1.31E-01	1.31E-03	2.52E-01
	C>8-C10 aliphatics	1.30E+02	<	4.9	2.45	2.57E+00	1.97E-02	3.80E+00
	C>10-C12 aliphatics	1.60E+02	<	9.8	4.9	5.13E+00	3.21E-02	6.18E+00
	C>12-C16 aliphatics	2.00E+02	<	25	12.5	1.31E+01	6.55E-02	1.26E+01
	C >16-C21aliphatics	2.70E+02	<	25	12.5	1.31E+01	4.85E-02	9.34E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.14E-03	4.03E-05	7.76E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.14E-03	3.41E-05	6.57E-03
	C >8 - C10 aromatics	1.20E+02	<	4.9	2.45	2.57E+00	2.14E-02	4.12E+00
	C>10-C12 aromatics	1.30E+02	<	9.8	4.9	5.13E+00	3.95E-02	7.61E+00
	C>12-C16 aromatics	1.50E+02	<	25	12.5	1.31E+01	8.73E-02	1.68E+01
	C>16-C21 aromatics	1.90E+02	<	25	12.5	1.31E+01	6.89E-02	1.33E+01
	C>21-C35 aromatics	2.40E+02	<	61	30.5	3.20E+01	1.33E-01	2.57E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	32.6	100	
aromatics	62.856		
Total	95.456		

(LOCATION): HP003-05
Commercial Receptor

Table A-7:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.4E-04	3.5E-03	8.6E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	5.7E-05	1.3E-05	2.6E-02	4.6E-03	3.8E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.1E-02	1.1E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.1E-02	2.3E-02	2.3E-02	4.1E-02	3.5E-04	2.3E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	6.0E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.9E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.1E-05	1.4E-03	1.4E-03	2.8E-03	7.4E-01	1.4E-03	4.7E-01	4.6E-02	2.4E-01	3.4E+00	3.4E-04
>7-8 Aromatics	3.1E-05	7.0E-06	7.0E-06	6.3E-05	1.3E-02	8.6E-06	4.8E-03	4.6E-04	4.4E-04	2.4E-02	8.8E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.8E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.1E-02	5.7E-02	5.7E-02	2.1E-01	1.3E-02	6.2E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.5E-01	1.5E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.2E-02	1.2E-01	2.5E-04	2.4E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.6E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)	**9.13E+04**	**5.78E+03**	**5.07E+11**	**5.01E+08**	**5.30E+03**	**3.53E+05**	**5.10E+02**	**8.50E+03**	**8.68E+08**	**9.21E+00**
RBSL(C_{TPH}) (mg/kg)	**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**400000**	**500**	**9000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-8 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP004-06

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.0037	0.0037	3.99E-03	5.11E-05	9.85E-03
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.4	0.2	2.16E-01	9.46E-04	1.82E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.4	0.2	2.16E-01	8.56E-04	1.65E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.4	0.2	2.16E-01	8.56E-04	1.65E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.4	0.2	2.16E-01	8.56E-04	1.65E-01
218-01-9	Chrysene	2.28E+02	<	0.4	0.2	2.16E-01	9.46E-04	1.82E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	2.16E-01	7.76E-04	1.49E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.4	0.2	2.16E-01	7.81E-04	1.51E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.24	0.12	1.29E-01	1.60E-03	3.08E-01
	C>6-C8 aliphatics	1.00E+02	<	0.24	0.12	1.29E-01	1.29E-03	2.49E-01
	C>8-C10 aliphatics	1.30E+02	<	4.8	2.4	2.59E+00	1.99E-02	3.83E+00
	C>10-C12 aliphatics	1.60E+02	<	9.7	4.85	5.23E+00	3.27E-02	6.30E+00
	C>12-C16 aliphatics	2.00E+02	<	24	12	1.29E+01	6.47E-02	1.25E+01
	C >16-C21aliphatics	2.70E+02	<	24	12	1.29E+01	4.79E-02	9.23E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.23E-03	4.15E-05	7.99E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.23E-03	3.51E-05	6.77E-03
	C >8 - C10 aromatics	1.20E+02	<	4.8	2.4	2.59E+00	2.16E-02	4.15E+00
	C>10-C12 aromatics	1.30E+02	<	9.7	4.85	5.23E+00	4.02E-02	7.75E+00
	C>12-C16 aromatics	1.50E+02	<	24	12	1.29E+01	8.63E-02	1.66E+01
	C>16-C21 aromatics	1.90E+02	<	24	12	1.29E+01	6.81E-02	1.31E+01
	C>21-C35 aromatics	2.40E+02	<	60	30	3.23E+01	1.35E-01	2.60E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	31.49	100	
aromatics	61.256		
Total	92.746		

(LOCATION): HP004-06
Commercial Receptor

Table A-9:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{isat} TPH fractions (I) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.3E-04	3.5E-03	8.4E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.2E-02	1.2E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.2E-02	2.3E-02	2.3E-02	4.2E-02	3.5E-04	2.4E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.2E-05	1.4E-03	1.4E-03	2.9E-03	7.4E-01	1.5E-03	4.8E-01	4.7E-02	2.4E-01	3.4E+00	3.5E-04
>7-8 Aromatics	3.2E-05	7.2E-06	7.2E-06	6.5E-05	1.3E-02	8.8E-06	4.8E-03	4.7E-04	4.4E-04	2.4E-02	9.0E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.7E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.2E-02	5.8E-02	5.8E-02	2.1E-01	1.3E-02	6.3E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	2.0E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.1E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)	**9.10E+04**	**5.76E+03**	**5.08E+11**	**5.01E+08**	**5.29E+03**	**3.46E+05**	**5.04E+02**	**8.36E+03**	**8.68E+08**	**9.14E+00**
RBSL(C_{TPH}) (mg/kg)	**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**300000**	**500**	**8000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm

Table A-10 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HF005-01

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.0061	0.0061	6.30E-03	8.08E-05	1.56E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.42	0.21	2.17E-01	9.52E-04	1.84E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.42	0.21	2.17E-01	8.61E-04	1.66E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.42	0.21	2.17E-01	8.61E-04	1.66E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.42	0.21	2.17E-01	8.61E-04	1.66E-01
218-01-9	Chysene	2.28E+02	<	0.42	0.21	2.17E-01	9.52E-04	1.84E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.42	0.21	2.17E-01	7.81E-04	1.51E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.42	0.21	2.17E-01	7.86E-04	1.52E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.25	0.125	1.29E-01	1.59E-03	3.08E-01
	C>6-C8 aliphatics	1.00E+02	<	0.25	0.125	1.29E-01	1.29E-03	2.49E-01
	C>8-C10 aliphatics	1.30E+02	<	5	2.5	2.58E+00	1.99E-02	3.83E+00
	C>10-C12 aliphatics	1.60E+02	<	10	5	5.17E+00	3.23E-02	6.23E+00
	C>12-C16 aliphatics	2.00E+02	<	25	12.5	1.29E+01	6.46E-02	1.25E+01
	C >16-C21aliphatics	2.70E+02	<	25	12.5	1.29E+01	4.78E-02	9.23E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.10E-03	3.98E-05	7.66E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.10E-03	3.37E-05	6.49E-03
	C >8 - C10 aromatics	1.20E+02	<	5	2.5	2.58E+00	2.15E-02	4.15E+00
	C>10-C12 aromatics	1.30E+02	<	10	5	5.17E+00	3.98E-02	7.66E+00
	C>12-C16 aromatics	1.50E+02	<	25	12.5	1.29E+01	8.61E-02	1.66E+01
	C>16-C21 aromatics	1.90E+02	<	25	12.5	1.29E+01	6.80E-02	1.31E+01
	C>21-C35 aromatics	2.40E+02	<	63	31.5	3.26E+01	1.36E-01	2.62E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	32.75	100	
aromatics	64.006		
Total	96.756		

(LOCATION): HP005-01
Commercial Receptor

Table A-11:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	1.3E-03	1.1E-05	1.1E-05	5.6E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.4E-04	3.5E-03	8.4E-04
>6-8 Aliphatics	1.3E-03	1.1E-05	1.1E-05	5.6E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.1E-02	1.1E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.2E-02	2.3E-02	2.3E-02	4.2E-02	3.5E-04	2.4E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.7E-02	5.7E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.1E-05	1.4E-03	1.4E-03	2.8E-03	7.4E-01	1.4E-03	4.7E-01	4.5E-02	2.3E-01	3.4E+00	3.4E-04
>7-8 Aromatics	3.1E-05	6.9E-06	6.9E-06	6.2E-05	1.3E-02	8.4E-06	4.8E-03	4.6E-04	4.3E-04	2.4E-02	8.6E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.8E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.2E-02	5.7E-02	5.7E-02	2.1E-01	1.3E-02	6.2E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.1E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.3E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)	9.09E+04	5.76E+03	5.10E+11	5.01E+08	5.28E+03	3.58E+05	5.07E+02	8.49E+03	8.68E+08	9.16E+00
RBSL(C_{TPH}) (mg/kg)	90000	6000	5E+11	>Csat	5000	400000	500	8000	900000000	9

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm

Table A-12 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP005-03

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.0052	0.0052	5.56E-03	7.13E-05	1.37E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.41	0.205	2.19E-01	9.62E-04	1.85E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.41	0.205	2.19E-01	8.71E-04	1.68E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.41	0.205	2.19E-01	8.71E-04	1.68E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.41	0.205	2.19E-01	8.71E-04	1.68E-01
218-01-9	Chrysene	2.28E+02	<	0.41	0.205	2.19E-01	9.62E-04	1.85E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.41	0.205	2.19E-01	7.89E-04	1.52E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.41	0.205	2.19E-01	7.95E-04	1.53E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.24	0.12	1.28E-01	1.59E-03	3.05E-01
	C>6-C8 aliphatics	1.00E+02	<	0.24	0.12	1.28E-01	1.28E-03	2.47E-01
	C>8-C10 aliphatics	1.30E+02	<	4.9	2.45	2.62E+00	2.02E-02	3.89E+00
	C>10-C12 aliphatics	1.60E+02	<	9.8	4.9	5.24E+00	3.28E-02	6.31E+00
	C>12-C16 aliphatics	2.00E+02	<	24	12	1.28E+01	6.42E-02	1.24E+01
	C >16-C21aliphatics	2.70E+02	<	24	12	1.28E+01	4.76E-02	9.16E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.21E-03	4.12E-05	7.93E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.21E-03	3.49E-05	6.72E-03
	C >8 - C10 aromatics	1.20E+02	<	4.9	2.45	2.62E+00	2.18E-02	4.21E+00
	C>10-C12 aromatics	1.30E+02	<	9.8	4.9	5.24E+00	4.03E-02	7.77E+00
	C>12-C16 aromatics	1.50E+02	<	24	12	1.28E+01	8.56E-02	1.65E+01
	C>16-C21 aromatics	1.90E+02	<	24	12	1.28E+01	6.76E-02	1.30E+01
	C>21-C35 aromatics	2.40E+02	<	61	30.5	3.26E+01	1.36E-01	2.62E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	31.59	100	
aromatics	61.856		
Total	93.446		

(LOCATION): HP005-03
Commercial Receptor

Table A-13:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	1.3E-03	1.1E-05	1.1E-05	5.6E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.3E-04	3.5E-03	8.3E-04
>6-8 Aliphatics	1.3E-03	1.1E-05	1.1E-05	5.6E-05	5.7E-05	1.3E-05	2.6E-02	4.4E-03	3.6E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.2E-02	1.2E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.2E-02	2.3E-02	2.3E-02	4.2E-02	3.5E-04	2.4E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.7E-02	5.7E-02	1.0E-01	1.6E-04	5.8E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.2E-05	1.4E-03	1.4E-03	2.9E-03	7.4E-01	1.5E-03	4.8E-01	4.6E-02	2.4E-01	3.4E+00	3.5E-04
>7-8 Aromatics	3.2E-05	7.1E-06	7.1E-06	6.4E-05	1.3E-02	8.7E-06	4.8E-03	4.7E-04	4.4E-04	2.4E-02	8.8E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.1E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.8E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.2E-02	5.8E-02	5.8E-02	2.1E-01	1.3E-02	6.3E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.0E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.3E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)	9.08E+04	5.75E+03	5.09E+11	5.01E+08	5.28E+03	3.49E+05	5.00E+02	8.32E+03	8.68E+08	9.03E+00
RBSL(C_{TPH}) (mg/kg)	90000	6000	5E+11	>Csat	5000	300000	500	8000	900000000	9

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface soil indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-14 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HF006-01

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.038	0.038	3.93E-02	5.04E-04	9.71E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.4	0.2	2.07E-01	9.07E-04	1.75E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.4	0.2	2.07E-01	8.20E-04	1.58E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.4	0.2	2.07E-01	8.20E-04	1.58E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.4	0.2	2.07E-01	8.20E-04	1.58E-01
218-01-9	Chrysene	2.28E+02	<	0.4	0.2	2.07E-01	9.07E-04	1.75E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	2.07E-01	7.44E-04	1.43E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.4	0.2	2.07E-01	7.49E-04	1.44E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.25	0.125	1.29E-01	1.59E-03	3.08E-01
	C>6-C8 aliphatics	1.00E+02	<	0.25	0.125	1.29E-01	1.29E-03	2.49E-01
	C>8-C10 aliphatics	1.30E+02	<	5	2.5	2.58E+00	1.99E-02	3.83E+00
	C>10-C12 aliphatics	1.60E+02	<	10	5	5.17E+00	3.23E-02	6.23E+00
	C>12-C16 aliphatics	2.00E+02	<	25	12.5	1.29E+01	6.46E-02	1.25E+01
	C >16-C21aliphatics	2.70E+02	<	25	12.5	1.29E+01	4.78E-02	9.23E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.10E-03	3.98E-05	7.66E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.10E-03	3.37E-05	6.49E-03
	C >8 - C10 aromatics	1.20E+02	<	5	2.5	2.58E+00	2.15E-02	4.15E+00
	C>10-C12 aromatics	1.30E+02	<	10	5	5.17E+00	3.98E-02	7.66E+00
	C>12-C16 aromatics	1.50E+02	<	25	12.5	1.29E+01	8.61E-02	1.66E+01
	C>16-C21 aromatics	1.90E+02	<	25	12.5	1.29E+01	6.80E-02	1.31E+01
	C>21-C35 aromatics	2.40E+02	<	63	31.5	3.26E+01	1.36E-01	2.62E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	32.75	100	
aromatics	64.006		
Total	96.756		

Table A-15:TPHCWG Demonstration, AF Plant 6 Fuel Farm

	$C_{i,sat}$ TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
		TPH Fraction Risk-Based Screening Levels (RBSLs)									
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC
	Weight Fraction (f_i) (mg/kg/mg/kg)	**Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)**									
>5-6 Aliphatics	1.3E-03	1.1E-05	1.1E-05	5.6E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.4E-04	3.5E-03	8.4E-04
>6-8 Aliphatics	1.3E-03	1.1E-05	1.1E-05	5.6E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.1E-02	1.1E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.2E-02	2.3E-02	2.3E-02	4.2E-02	3.5E-04	2.4E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.7E-02	5.7E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.1E-05	1.4E-03	1.4E-03	2.8E-03	7.4E-01	1.4E-03	4.7E-01	4.5E-02	2.3E-01	3.4E+00	3.4E-04
>7-8 Aromatics	3.1E-05	6.9E-06	6.9E-06	6.2E-05	1.3E-02	8.4E-06	4.8E-03	4.6E-04	4.3E-04	2.4E-02	8.6E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.8E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.2E-02	5.7E-02	5.7E-02	2.1E-01	1.3E-02	6.2E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.1E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.3E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00
		TPH Risk Based Screening Levels									
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		9.09E+04	5.75E+03	5.10E+11	5.01E+08	5.28E+03	3.58E+05	5.07E+02	8.49E+03	8.68E+08	9.16E+00
RBSL(C_{TPH}) (mg/kg)		90000	6000	5E+11	>Csat	5000	400000	500	8000	900000000	9

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm

Table A-16 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Scil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP006-02

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.0065	0.0065	7.02E-03	8.99E-05	1.73E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.4	0.2	2.16E-01	9.47E-04	1.82E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.4	0.2	2.16E-01	8.57E-04	1.65E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.4	0.2	2.16E-01	8.57E-04	1.65E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.4	0.2	2.16E-01	8.57E-04	1.65E-01
218-01-9	Chrysene	2.28E+02	<	0.4	0.2	2.16E-01	9.47E-04	1.82E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	2.16E-01	7.77E-04	1.50E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.4	0.2	2.16E-01	7.82E-04	1.51E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.24	0.12	1.30E-01	1.60E-03	3.08E-01
	C>6-C8 aliphatics	1.00E+02	<	0.24	0.12	1.30E-01	1.30E-03	2.50E-01
	C>8-C10 aliphatics	1.30E+02	<	4.8	2.4	2.59E+00	1.99E-02	3.84E+00
	C>10-C12 aliphatics	1.60E+02	<	9.6	4.8	5.18E+00	3.24E-02	6.24E+00
	C>12-C16 aliphatics	2.00E+02	<	24	12	1.30E+01	6.48E-02	1.25E+01
	C >16-C21aliphatics	2.70E+02	<	24	12	1.30E+01	4.80E-02	9.25E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.24E-03	4.15E-05	8.00E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.24E-03	3.52E-05	6.78E-03
	C >8 - C10 aromatics	1.20E+02	<	4.8	2.4	2.59E+00	2.16E-02	4.16E+00
	C>10-C12 aromatics	1.30E+02	<	9.6	4.8	5.18E+00	3.99E-02	7.68E+00
	C>12-C16 aromatics	1.50E+02	<	24	12	1.30E+01	8.64E-02	1.66E+01
	C>16-C21 aromatics	1.90E+02	<	24	12	1.30E+01	6.82E-02	1.31E+01
	C>21-C35 aromatics	2.40E+02	<	60	30	3.24E+01	1.35E-01	2.60E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	31.44	100	
aromatics	61.206		
Total	92.646		

(LOCATION): HP006-02
Commercial Receptor

Table A-17:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{isat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.3E-04	3.5E-03	8.4E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.2E-02	1.2E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.2E-02	2.3E-02	2.3E-02	4.2E-02	3.5E-04	2.4E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.2E-05	1.4E-03	1.4E-03	2.9E-03	7.4E-01	1.5E-03	4.8E-01	4.7E-02	2.4E-01	3.4E+00	3.5E-04
>7-8 Aromatics	3.2E-05	7.2E-06	7.2E-06	6.5E-05	1.3E-02	8.8E-06	4.8E-03	4.7E-04	4.5E-04	2.4E-02	9.0E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.7E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.2E-02	5.8E-02	5.8E-02	2.1E-01	1.3E-02	6.2E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.1E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

		Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		**9.10E+04**	**5.76E+03**	**5.09E+11**	**5.01E+08**	**5.29E+03**	**3.46E+05**	**5.05E+02**	**8.38E+03**	**8.68E+08**	**9.13E+00**
RBSL(C_{TPH}) (mg/kg)		**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**300000**	**500**	**8000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-18 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP006-11

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.0065	0.0065	7.08E-03	9.07E-05	1.75E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.4	0.2	2.18E-01	9.55E-04	1.84E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.4	0.2	2.18E-01	8.64E-04	1.67E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.4	0.2	2.18E-01	8.64E-04	1.67E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.4	0.2	2.18E-01	8.64E-04	1.67E-01
218-01-9	Chrysene	2.28E+02	<	0.4	0.2	2.18E-01	9.55E-04	1.84E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	2.18E-01	7.83E-04	1.51E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.4	0.2	2.18E-01	7.89E-04	1.52E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.24	0.12	1.31E-01	1.61E-03	3.11E-01
	C>6-C8 aliphatics	1.00E+02	<	0.24	0.12	1.31E-01	1.31E-03	2.52E-01
	C>8-C10 aliphatics	1.30E+02	<	4.7	2.35	2.56E+00	1.97E-02	3.79E+00
	C>10-C12 aliphatics	1.60E+02	<	9.4	4.7	5.12E+00	3.20E-02	6.17E+00
	C>12-C16 aliphatics	2.00E+02	<	24	12	1.31E+01	6.53E-02	1.26E+01
	C >16-C21aliphatics	2.70E+02	<	24	12	1.31E+01	4.84E-02	9.33E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.27E-03	4.19E-05	8.07E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.27E-03	3.55E-05	6.84E-03
	C >8 - C10 aromatics	1.20E+02	<	4.7	2.35	2.56E+00	2.13E-02	4.11E+00
	C>10-C12 aromatics	1.30E+02	<	9.4	4.7	5.12E+00	3.94E-02	7.59E+00
	C>12-C16 aromatics	1.50E+02	<	24	12	1.31E+01	8.71E-02	1.68E+01
	C>16-C21 aromatics	1.90E+02	<	24	12	1.31E+01	6.88E-02	1.33E+01
	C>21-C35 aromatics	2.40E+02	<	59	29.5	3.21E+01	1.34E-01	2.58E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	31.29	100	
aromatics	60.556		
Total	91.846		

(LOCATION): HP006-11
Commercial Receptor

Table A-19:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{last} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC
	Weight Fraction (f_i) (mg/kg/mg/kg)				**Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)**						
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.4E-04	3.5E-03	8.6E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.1E-02	1.1E-02	2.0E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.1E-02	2.3E-02	2.3E-02	4.1E-02	3.5E-04	2.3E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	6.0E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.3E-05	1.5E-03	1.5E-03	2.9E-03	7.4E-01	1.5E-03	4.8E-01	4.8E-02	2.4E-01	3.4E+00	3.6E-04
>7-8 Aromatics	3.3E-05	7.3E-06	7.3E-06	6.5E-05	1.3E-02	8.9E-06	4.8E-03	4.8E-04	4.5E-04	2.4E-02	9.1E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.7E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.1E-02	5.7E-02	5.7E-02	2.0E-01	1.3E-02	6.1E-02	3.1E-02	8.6E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.5E-01	1.5E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.2E-02	1.2E-01	2.5E-04	2.4E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00
						TPH Risk Based Screening Levels					
		(mg/kg)	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/L)**	**(mg/L)**
Total TPH (mg/kg)		**9.12E+04**	**5.77E+03**	**5.09E+11**	**5.01E+08**	**5.30E+03**	**3.43E+05**	**5.10E+02**	**8.43E+03**	**8.68E+08**	**9.24E+00**
RBSL(C_{TPH}) (mg/kg)		**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**300000**	**500**	**8000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-20 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP007-01

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		29	29	9.34E-01	1.20E-02	1.85E+00
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.43	0.215	6.93E-03	3.04E-05	4.69E-03
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.43	0.215	6.93E-03	2.75E-05	4.24E-03
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.43	0.215	6.93E-03	2.75E-05	4.24E-03
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.43	0.215	6.93E-03	2.75E-05	4.24E-03
218-01-9	Chrysene	2.28E+02	<	0.43	0.215	6.93E-03	3.04E-05	4.69E-03
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.43	0.215	6.93E-03	2.49E-05	3.85E-03
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.43	0.215	6.93E-03	2.51E-05	3.88E-03
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	50	25	8.06E-01	9.95E-03	1.54E+00
	C>6-C8 aliphatics	1.00E+02	<	50	25	8.06E-01	8.06E-03	1.24E+00
	C>8-C10 aliphatics	1.30E+02		670	670	2.16E+01	1.66E-01	2.56E+01
	C>10-C12 aliphatics	1.60E+02		1400	1400	4.51E+01	2.82E-01	4.35E+01
	C>12-C16 aliphatics	2.00E+02		600	600	1.93E+01	9.67E-02	1.49E+01
	C >16-C21aliphatics	2.70E+02	<	50	25	8.06E-01	2.98E-03	4.61E-01
	C>5-C7 aromatics	7.80E+01	<	1.3	0.65	2.09E-02	2.69E-04	4.15E-02
	C>7-C8 aromatics	9.21E+01	<	1.3	0.65	2.09E-02	2.27E-04	3.51E-02
	C >8 - C10 aromatics	1.20E+02		38	38	1.22E+00	1.02E-02	1.58E+00
	C>10-C12 aromatics	1.30E+02		180	180	5.80E+00	4.46E-02	6.89E+00
	C>12-C16 aromatics	1.50E+02		95	95	3.06E+00	2.04E-02	3.15E+00
	C>16-C21 aromatics	1.90E+02	<	25	12.5	4.03E-01	2.12E-03	3.27E-01
	C>21-C35 aromatics	2.40E+02	<	63	31.5	1.02E+00	4.23E-03	6.53E-01

Total TPH fractions		*Sum of weight %*	6.48E-01
aliphatics	2745	100	
aromatics	358.3		
Total	3103.3		

(LOCATION): HP007-01
Commercial Receptor

Table A-21:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

TPH fractions (i)	C_{isat} (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	8.1E-03	1.4E-04	1.4E-04	3.2E-04	1.0E-04	1.5E-04	1.2E-01	1.3E-02	3.8E-04	3.5E-03	6.8E-04
>6-8 Aliphatics	8.1E-03	1.4E-04	1.4E-04	3.2E-04	5.7E-05	1.5E-04	2.6E-02	5.3E-03	1.0E-04	7.9E-04	1.0E-03
>8-10 Aliphatics	2.2E-01	1.8E-01	1.8E-01	1.6E-01	5.8E-04	1.8E-01	6.1E-02	6.1E-01	3.5E-03	1.9E-03	8.2E-01
>10-12 Aliphatics	4.5E-01	3.8E-01	3.8E-01	3.2E-01	3.5E-04	3.8E-01	7.3E-03	2.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.9E-01	1.6E-01	1.6E-01	1.4E-01	1.6E-04	1.6E-01	7.0E-04	2.3E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	8.1E-03	3.4E-04	3.4E-04	0.0E+00	0.0E+00	3.2E-04	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	2.1E-04	1.8E-02	1.8E-02	1.7E-02	7.4E-01	1.8E-02	5.5E-01	5.8E-02	7.1E-01	3.4E+00	3.0E-04
>7-8 Aromatics	2.1E-04	8.9E-05	8.9E-05	3.8E-04	1.3E-02	1.0E-04	5.6E-03	5.9E-04	1.3E-03	2.4E-02	7.6E-06
>8-10 Aromatics	1.2E-02	2.6E-02	2.6E-02	4.4E-02	2.1E-02	2.7E-02	2.0E-01	2.1E-02	5.9E-02	1.1E-02	1.6E-03
>10-12 Aromatics	5.8E-02	1.2E-01	1.2E-01	2.1E-01	1.3E-02	1.3E-01	3.1E-02	1.9E-02	1.8E-01	1.8E-03	2.8E-03
>12-16 Aromatics	3.1E-02	6.5E-02	6.5E-02	1.1E-01	4.6E-03	6.6E-02	2.7E-03	1.9E-03	4.7E-02	2.5E-04	7.1E-04
>16-21 Aromatics	4.0E-03	1.1E-02	1.1E-02	0.0E+00	0.0E+00	1.1E-02	0.0E+00	0.0E+00	2.6E-03	0.0E+00	0.0E+00
>21-35 Aromatics	1.0E-02	2.9E-02	2.9E-02	0.0E+00	0.0E+00	2.7E-02	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)	1.73E+05	1.09E+04	4.57E+11	5.01E+08	9.74E+03	6.13E+04	9.72E+01	3.83E+03	8.68E+08	1.19E+00
RBSL(C_{TPH}) (mg/kg)	200000	10000	5E+11	>Csat	10000	60000	100	4000	900000000	1

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-22 (Composition Data)

(MM/DD/YR) 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION) HP008-01

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		28	28	4.97E-01	6.37E-03	1.10E+00
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.075	0.0375	6.65E-04	2.92E-06	5.05E-04
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.39	0.195	3.46E-03	1.37E-05	2.37E-03
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.39	0.195	3.46E-03	1.37E-05	2.37E-03
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.39	0.195	3.46E-03	1.37E-05	2.37E-03
218-01-9	Chrysene	2.28E+02	<	0.065	0.0325	5.77E-04	2.53E-06	4.37E-04
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.39	0.195	3.46E-03	1.24E-05	2.15E-03
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.39	0.195	3.46E-03	1.25E-05	2.17E-03
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	9.7	4.85	8.61E-02	1.06E-03	1.84E-01
	C>6-C8 aliphatics	1.00E+02		13	13	2.31E-01	2.31E-03	3.99E-01
	C>8-C10 aliphatics	1.30E+02		230	230	4.08E+00	3.14E-02	5.43E+00
	C>10-C12 aliphatics	1.60E+02		1700	1700	3.02E+01	1.89E-01	3.26E+01
	C>12-C16 aliphatics	2.00E+02		2700	2700	4.79E+01	2.40E-01	4.14E+01
	C >16-C21aliphatics	2.70E+02	<	120	60	1.06E+00	3.94E-03	6.82E-01
	C>5-C7 aromatics	7.80E+01	<	0.244	0.122	2.16E-03	2.78E-05	4.80E-03
	C>7-C8 aromatics	9.21E+01	<	0.244	0.122	2.16E-03	2.35E-05	4.06E-03
	C >8 - C10 aromatics	1.20E+02		5.2	5.2	9.23E-02	7.69E-04	1.33E-01
	C>10-C12 aromatics	1.30E+02		210	210	3.73E+00	2.87E-02	4.96E+00
	C>12-C16 aromatics	1.50E+02		650	650	1.15E+01	7.69E-02	1.33E+01
	C>16-C21 aromatics	1.90E+02		32	32	5.68E-01	2.99E-03	5.17E-01
	C>21-C35 aromatics	2.40E+02	<	61	30.5	5.41E-01	2.25E-03	3.90E-01

Total TPH fractions		*Sum of weight %*	5.78E-01
aliphatics	4707.85	100	
aromatics	927.944		
Total	5635.794		

(LOCATION): HP008-01
Commercial Receptor

Table A-23:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	8.6E-04	1.4E-05	1.4E-05	2.9E-05	1.0E-04	1.5E-05	1.2E-01	4.4E-03	1.9E-04	3.5E-03	3.8E-04
>6-8 Aliphatics	2.3E-03	3.7E-05	3.7E-05	7.9E-05	5.7E-05	4.0E-05	2.6E-02	4.9E-03	1.4E-04	7.9E-04	1.5E-03
>8-10 Aliphatics	4.1E-02	3.3E-02	3.3E-02	2.6E-02	5.8E-04	3.3E-02	6.1E-02	3.7E-01	3.5E-03	1.9E-03	8.0E-01
>10-12 Aliphatics	3.0E-01	2.4E-01	2.4E-01	1.9E-01	3.5E-04	2.4E-01	7.3E-03	4.9E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	4.8E-01	3.8E-01	3.8E-01	3.0E-01	1.6E-04	3.8E-01	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.1E-02	4.3E-04	4.3E-04	0.0E+00	0.0E+00	4.0E-04	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	2.2E-05	1.7E-03	1.7E-03	1.5E-03	7.4E-01	1.7E-03	5.9E-01	1.9E-02	3.4E-01	3.4E+00	1.6E-04
>7-8 Aromatics	2.2E-05	8.7E-06	8.7E-06	3.4E-05	1.3E-02	1.0E-05	6.0E-03	2.0E-04	6.3E-04	2.4E-02	4.0E-06
>8-10 Aromatics	9.2E-04	1.9E-03	1.9E-03	2.9E-03	2.1E-02	1.9E-03	1.6E-01	5.2E-03	2.1E-02	1.1E-02	6.3E-04
>10-12 Aromatics	3.7E-02	7.5E-02	7.5E-02	1.2E-01	1.3E-02	7.8E-02	3.1E-02	3.9E-02	5.0E-01	1.8E-03	9.4E-03
>12-16 Aromatics	1.2E-01	2.3E-01	2.3E-01	3.6E-01	4.6E-03	2.4E-01	2.7E-03	2.3E-02	1.2E-01	2.5E-04	1.4E-02
>16-21 Aromatics	5.7E-03	1.5E-02	1.5E-02	0.0E+00	0.0E+00	1.4E-02	0.0E+00	0.0E+00	1.7E-02	0.0E+00	0.0E+00
>21-35 Aromatics	5.4E-03	1.4E-02	1.4E-02	0.0E+00	0.0E+00	1.4E-02	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

		Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
		(mg/kg)	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/L)**	**(mg/L)**
Total TPH (mg/kg)		**1.64E+05**	**1.04E+04**	**3.99E+11**	**5.01E+08**	**9.23E+03**	**6.40E+05**	**3.13E+02**	**1.76E+04**	**8.68E+08**	**6.15E+00**
RBSL(C_{TPH}) (mg/kg)		**200000**	**10000**	**4E+11**	**>Csat**	**9000**	**600000**	**300**	**20000**	**900000000**	**6**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm

Table A-24 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HF008-03

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		1.3	1.3	5.31E-02	6.80E-04	1.18E-01
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.39	0.195	7.96E-03	3.49E-05	6.05E-03
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.39	0.195	7.96E-03	3.16E-05	5.47E-03
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.39	0.195	7.96E-03	3.16E-05	5.47E-03
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.39	0.195	7.96E-03	3.16E-05	5.47E-03
218-01-9	Chrysene	2.28E+02	<	0.39	0.195	7.96E-03	3.49E-05	6.05E-03
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.39	0.195	7.96E-03	2.86E-05	4.96E-03
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.39	0.195	7.96E-03	2.88E-05	5.00E-03
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	2.4	1.2	4.90E-02	6.05E-04	1.05E-01
	C>6-C8 aliphatics	1.00E+02		8.17	8.17	3.33E-01	3.33E-03	5.78E-01
	C>8-C10 aliphatics	1.30E+02		83	83	3.39E+00	2.61E-02	4.52E+00
	C>10-C12 aliphatics	1.60E+02		660	660	2.69E+01	1.68E-01	2.92E+01
	C>12-C16 aliphatics	2.00E+02		1200	1200	4.90E+01	2.45E-01	4.24E+01
	C >16-C21aliphatics	2.70E+02	<	48	24	9.79E-01	3.63E-03	6.29E-01
	C>5-C7 aromatics	7.80E+01	<	0.059	0.0295	1.20E-03	1.54E-05	2.68E-03
	C>7-C8 aromatics	9.21E+01	<	0.059	0.0295	1.20E-03	1.31E-05	2.27E-03
	C >8 - C10 aromatics	1.20E+02	<	4.8	2.4	9.79E-02	8.16E-04	1.41E-01
	C>10-C12 aromatics	1.30E+02		110	110	4.49E+00	3.45E-02	5.99E+00
	C>12-C16 aromatics	1.50E+02		320	320	1.31E+01	8.71E-02	1.51E+01
	C>16-C21 aromatics	1.90E+02	<	24	12	4.90E-01	2.58E-03	4.47E-01
	C>21-C35 aromatics	2.40E+02	<	59	29.5	1.20E+00	5.02E-03	8.70E-01

Total TPH fractions		*Sum of weight %*	5.77E-01
aliphatics	1976.37	100	
aromatics	473.959		
Total	2450.329		

Table A-25:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil; Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil; Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	4.9E-04	7.6E-06	7.6E-06	1.6E-05	1.0E-04	8.1E-06	1.2E-01	2.9E-03	1.8E-04	3.5E-03	2.6E-04
>6-8 Aliphatics	3.3E-03	5.2E-05	5.2E-05	1.1E-04	5.7E-05	5.5E-05	2.6E-02	8.2E-03	3.4E-04	7.9E-04	2.6E-03
>8-10 Aliphatics	3.4E-02	2.6E-02	2.6E-02	2.0E-02	5.8E-04	2.6E-02	6.1E-02	3.5E-01	3.5E-03	1.9E-03	7.9E-01
>10-12 Aliphatics	2.7E-01	2.1E-01	2.1E-01	1.6E-01	3.5E-04	2.1E-01	7.3E-03	4.9E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	4.9E-01	3.8E-01	3.8E-01	2.9E-01	1.6E-04	3.8E-01	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	9.8E-03	3.8E-04	3.8E-04	0.0E+00	0.0E+00	3.6E-04	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	1.2E-05	9.3E-04	9.3E-04	8.0E-04	7.4E-01	9.3E-04	5.0E-01	1.2E-02	3.2E-01	3.4E+00	1.0E-04
>7-8 Aromatics	1.2E-05	4.7E-06	4.7E-06	1.8E-05	1.3E-02	5.5E-06	5.0E-03	1.3E-04	5.9E-04	2.4E-02	2.7E-06
>8-10 Aromatics	9.8E-04	1.9E-03	1.9E-03	2.9E-03	2.1E-02	2.0E-03	2.5E-01	6.3E-03	3.7E-02	1.1E-02	8.0E-04
>10-12 Aromatics	4.5E-02	8.7E-02	8.7E-02	1.3E-01	1.3E-02	9.0E-02	3.1E-02	5.3E-02	5.0E-01	1.8E-03	1.3E-02
>12-16 Aromatics	1.3E-01	2.5E-01	2.5E-01	3.9E-01	4.6E-03	2.6E-01	2.7E-03	3.0E-02	1.2E-01	2.5E-04	1.9E-02
>16-21 Aromatics	4.9E-03	1.3E-02	1.3E-02	0.0E+00	0.0E+00	1.2E-02	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	1.2E-02	3.1E-02	3.1E-02	0.0E+00	0.0E+00	2.9E-02	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

		Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil; Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		1.68E+05	1.00E+04	3.79E+11	5.01E+08	8.89E+03	9.67E+05	3.69E+02	3.00E+04	8.68E+08	7.31E+00
RBSL(C_{TPH}) (mg/kg)		200000	10000	4E+11	>Csat	9000	1000000	400	30000	900000000	7

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-26 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP009-01

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		31	31	4.86E-01	6.24E-03	1.04E+00
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.2	0.1	1.57E-03	6.88E-06	1.14E-03
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.13	0.065	1.02E-03	4.05E-06	6.73E-04
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.18	0.09	1.41E-03	5.60E-06	9.32E-04
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.074	0.037	5.81E-04	2.30E-06	3.83E-04
218-01-9	Chrysene	2.28E+02	<	0.18	0.09	1.41E-03	6.19E-06	1.03E-03
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	3.14E-03	1.13E-05	1.88E-03
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.4	0.2	3.14E-03	1.14E-05	1.89E-03
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	9.7	4.85	7.61E-02	9.40E-04	1.56E-01
	C>6-C8 aliphatics	1.00E+02		54.89	54.89	8.61E-01	8.61E-03	1.43E+00
	C>8-C10 aliphatics	1.30E+02		540	540	8.47E+00	6.52E-02	1.08E+01
	C>10-C12 aliphatics	1.60E+02		2000	2000	3.14E+01	1.96E-01	3.26E+01
	C>12-C16 aliphatics	2.00E+02		2500	2500	3.92E+01	1.96E-01	3.26E+01
	C >16-C21aliphatics	2.70E+02	<	120	60	9.41E-01	3.49E-03	5.80E-01
	C>5-C7 aromatics	7.80E+01	<	0.2	0.1	1.57E-03	2.01E-05	3.34E-03
	C>7-C8 aromatics	9.21E+01	<	0.2	0.1	1.57E-03	1.70E-05	2.83E-03
	C >8 - C10 aromatics	1.20E+02		16	16	2.51E-01	2.09E-03	3.48E-01
	C>10-C12 aromatics	1.30E+02		350	350	5.49E+00	4.22E-02	7.02E+00
	C>12-C16 aromatics	1.50E+02		780	780	1.22E+01	8.16E-02	1.36E+01
	C>16-C21 aromatics	1.90E+02		37	37	5.81E-01	3.06E-03	5.08E-01
	C>21-C35 aromatics	2.40E+02	<	60	30	4.71E-01	1.96E-03	3.26E-01

Total TPH fractions		*Sum of weight %*	6.01E-01
aliphatics	5159.74	100	
aromatics	1213.2		
Total	6372.94		

(LOCATION): HP009-01
Commercial Receptor

Table A-27:TPHCWG Demonstration, AF Plant 6 Fuel Farm

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
		TPH Fraction Risk-Based Screening Levels (RBSLs)									
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC
	Weight Fraction (f_i) (mg/kg/mg/kg)	**Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)**									
>5-6 Aliphatics	7.6E-04	1.2E-05	1.2E-05	2.4E-05	1.0E-04	1.3E-05	1.2E-01	2.6E-03	2.0E-04	3.5E-03	1.6E-04
>6-8 Aliphatics	8.6E-03	1.3E-04	1.3E-04	2.8E-04	5.7E-05	1.4E-04	2.6E-02	1.2E-02	6.1E-04	7.9E-04	2.8E-03
>8-10 Aliphatics	8.5E-02	6.6E-02	6.6E-02	5.0E-02	5.8E-04	6.6E-02	6.1E-02	5.0E-01	3.5E-03	1.9E-03	8.0E-01
>10-12 Aliphatics	3.1E-01	2.5E-01	2.5E-01	1.9E-01	3.5E-04	2.4E-01	7.3E-03	3.6E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	3.9E-01	3.1E-01	3.1E-01	2.3E-01	1.6E-04	3.0E-01	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	9.4E-03	3.7E-04	3.7E-04	0.0E+00	0.0E+00	3.5E-04	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	1.6E-05	1.2E-03	1.2E-03	1.0E-03	7.4E-01	1.2E-03	4.7E-01	9.2E-03	2.9E-01	3.4E+00	5.6E-05
>7-8 Aromatics	1.6E-05	6.1E-06	6.1E-06	2.3E-05	1.3E-02	7.2E-06	4.8E-03	9.3E-05	5.4E-04	2.4E-02	1.4E-06
>8-10 Aromatics	2.5E-03	4.9E-03	4.9E-03	7.4E-03	2.1E-02	5.1E-03	2.8E-01	9.2E-03	6.6E-02	1.1E-02	8.4E-04
>10-12 Aromatics	5.5E-02	1.1E-01	1.1E-01	1.6E-01	1.3E-02	1.1E-01	3.1E-02	3.7E-02	5.0E-01	1.8E-03	6.8E-03
>12-16 Aromatics	1.2E-01	2.4E-01	2.4E-01	3.6E-01	4.6E-03	2.4E-01	2.7E-03	1.6E-02	1.2E-01	2.5E-04	7.2E-03
>16-21 Aromatics	5.8E-03	1.5E-02	1.5E-02	0.0E+00	0.0E+00	1.4E-02	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	4.7E-03	1.2E-02	1.2E-02	0.0E+00	0.0E+00	1.2E-02	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00
		TPH Risk Based Screening Levels									
		(mg/kg)	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/kg)**	**(mg/L)**	**(mg/L)**
Total TPH (mg/kg		**1.60E+05**	**1.01E+04**	**3.75E+11**	**5.01E+08**	**8.98E+03**	**7.06E+06**	**2.05E+02**	**2.09E+04**	**8.68E+08**	**2.99E+00**
RBSL(C_{TPH}) (mg/kg)		**200000**	**10000**	**4E+11**	**>Csat**	**9000**	**700000**	**200**	**20000**	**900000000**	**3**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-28 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP009-02

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		30	30	3.27E-01	4.19E-03	6.89E-01
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.43	0.215	2.34E-03	1.03E-05	1.69E-03
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.32	0.16	1.74E-03	6.91E-06	1.14E-03
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.41	0.205	2.23E-03	8.86E-06	1.46E-03
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.17	0.085	9.26E-04	3.67E-06	6.04E-04
218-01-9	Chrysene	2.28E+02	<	0.44	0.22	2.40E-03	1.05E-05	1.73E-03
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.41	0.205	2.23E-03	8.03E-06	1.32E-03
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.12	0.06	6.53E-04	2.37E-06	3.89E-04
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	50	25	2.72E-01	3.36E-03	5.53E-01
	C>6-C8 aliphatics	1.00E+02		143	143	1.56E+00	1.56E-02	2.56E+00
	C>8-C10 aliphatics	1.30E+02		980	980	1.07E+01	8.21E-02	1.35E+01
	C>10-C12 aliphatics	1.60E+02		2900	2900	3.16E+01	1.97E-01	3.25E+01
	C>12-C16 aliphatics	2.00E+02		3600	3600	3.92E+01	1.96E-01	3.22E+01
	C >16-C21aliphatics	2.70E+02	<	130	65	7.08E-01	2.62E-03	4.31E-01
	C>5-C7 aromatics	7.80E+01	<	1.3	0.65	7.08E-03	9.07E-05	1.49E-02
	C>7-C8 aromatics	9.21E+01	<	1.3	0.65	7.08E-03	7.68E-05	1.26E-02
	C >8 - C10 aromatics	1.20E+02		28	28	3.05E-01	2.54E-03	4.18E-01
	C>10-C12 aromatics	1.30E+02		450	450	4.90E+00	3.77E-02	6.20E+00
	C>12-C16 aromatics	1.50E+02		930	930	1.01E+01	6.75E-02	1.11E+01
	C>16-C21 aromatics	1.90E+02		30	30	3.27E-01	1.72E-03	2.83E-01
	C>21-C35 aromatics	2.40E+02	<	63	31.5	3.43E-01	1.43E-03	2.35E-01

Total TPH fractions		*Sum of weight %*	6.08E-01
aliphatics	7713	100	
aromatics	1470.8		
Total	9183.8		

(LOCATION): HP009-(2
Commercial Receptor

Table A-29:TPHCWG Demonstration, AF Plant 6 Fuel Farm

	$C_{i,sat}$ TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
		TPH Fraction Risk-Based Screening Levels (RBSLs)									
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC
	Weight Fraction (f_i) (mg/kg/mg/kg)	**Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)**									
>5-6 Aliphatics	2.7E-03	4.4E-05	4.4E-05	9.3E-05	1.0E-04	4.8E-05	1.2E-01	7.7E-03	2.8E-04	3.5E-03	4.6E-04
>6-8 Aliphatics	1.6E-02	2.5E-04	2.5E-04	5.3E-04	5.7E-05	2.7E-04	2.6E-02	1.8E-02	4.4E-04	7.9E-04	4.0E-03
>8-10 Aliphatics	1.1E-01	8.7E-02	8.7E-02	6.7E-02	5.8E-04	8.6E-02	6.1E-02	5.3E-01	3.5E-03	1.9E-03	8.1E-01
>10-12 Aliphatics	3.2E-01	2.6E-01	2.6E-01	2.0E-01	3.5E-04	2.5E-01	7.3E-03	3.1E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	3.9E-01	3.2E-01	3.2E-01	2.5E-01	1.6E-04	3.2E-01	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	7.1E-03	2.9E-04	2.9E-04	0.0E+00	0.0E+00	2.7E-04	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	7.1E-05	5.8E-03	5.8E-03	4.9E-03	7.4E-01	5.7E-03	5.9E-01	3.5E-02	5.2E-01	3.4E+00	2.0E-04
>7-8 Aromatics	7.1E-05	2.9E-05	2.9E-05	1.1E-04	1.3E-02	3.4E-05	6.0E-03	3.5E-04	9.6E-04	2.4E-02	5.1E-06
>8-10 Aromatics	3.0E-03	6.2E-03	6.2E-03	9.6E-03	2.1E-02	6.4E-03	1.6E-01	9.4E-03	3.2E-02	1.1E-02	8.1E-04
>10-12 Aromatics	4.9E-02	1.0E-01	1.0E-01	1.5E-01	1.3E-02	1.0E-01	3.1E-02	2.8E-02	3.2E-01	1.8E-03	4.8E-03
>12-16 Aromatics	1.0E-01	2.1E-01	2.1E-01	3.2E-01	4.6E-03	2.1E-01	2.7E-03	1.1E-02	1.2E-01	2.5E-04	4.7E-03
>16-21 Aromatics	3.3E-03	8.9E-03	8.9E-03	0.0E+00	0.0E+00	8.4E-03	0.0E+00	0.0E+00	4.6E-03	0.0E+00	0.0E+00
>21-35 Aromatics	3.4E-03	9.3E-03	9.3E-03	0.0E+00	0.0E+00	8.8E-03	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00
		TPH Risk Based Screening Levels									
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		**1.66E+05**	**1.06E+04**	**3.99E+11**	**5.01E+08**	**9.36E+03**	**1.95E+05**	**1.73E+02**	**8.27E+03**	**8.68E+08**	**2.38E+00**
RBSL(C_{TPH}) (mg/kg)		**200000**	**10000**	**4E+11**	**>Csat**	**9000**	**200000**	**200**	**8000**	**900000000**	**2**

Pathways:

- surface soil ingestion = incidental ingestion of surficial soil
- surface soil dermal = dermal contact with surficial soil
- fugitive dust inhalation = inhalation of dust from surface soil
- surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
- surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
- surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
- subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
- subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
- gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
- gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
- gw ingestion = ingestion of groundwater
- subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-30 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP010-01

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E		0.0055	0.0055	5.73E-03	7.35E-05	1.42E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.4	0.2	2.08E-01	9.14E-04	1.76E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.4	0.2	2.08E-01	8.27E-04	1.60E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.4	0.2	2.08E-01	8.27E-04	1.60E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.4	0.2	2.08E-01	8.27E-04	1.60E-01
218-01-9	Chrysene	2.28E+02	<	0.4	0.2	2.08E-01	9.14E-04	1.76E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	2.08E-01	7.50E-04	1.45E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.4	0.2	2.08E-01	7.55E-04	1.46E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.25	0.125	1.30E-01	1.61E-03	3.10E-01
	C>6-C8 aliphatics	1.00E+02	<	0.25	0.125	1.30E-01	1.30E-03	2.51E-01
	C>8-C10 aliphatics	1.30E+02	<	4.9	2.45	2.55E+00	1.96E-02	3.79E+00
	C>10-C12 aliphatics	1.60E+02	<	9.8	4.9	5.11E+00	3.19E-02	6.16E+00
	C>12-C16 aliphatics	2.00E+02	<	25	12.5	1.30E+01	6.51E-02	1.26E+01
	C >16-C21aliphatics	2.70E+02	<	25	12.5	1.30E+01	4.82E-02	9.31E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.13E-03	4.01E-05	7.73E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.13E-03	3.39E-05	6.55E-03
	C >8 - C10 aromatics	1.20E+02	<	4.9	2.45	2.55E+00	2.13E-02	4.10E+00
	C>10-C12 aromatics	1.30E+02	<	9.8	4.9	5.11E+00	3.93E-02	7.58E+00
	C>12-C16 aromatics	1.50E+02	<	25	12.5	1.30E+01	8.68E-02	1.67E+01
	C>16-C21 aromatics	1.90E+02	<	25	12.5	1.30E+01	6.86E-02	1.32E+01
	C>21-C35 aromatics	2.40E+02	<	62	31	3.23E+01	1.35E-01	2.60E+01

Total TPH fractions		*Sum of weight %*	5.18E-01
aliphatics	32.6	100	
aromatics	63.356		
Total	95.956		

(LOCATION): HP010-01
Commercial Receptor

Table A-31:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)										
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.4E-04	3.5E-03	8.6E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	5.7E-05	1.3E-05	2.6E-02	4.6E-03	3.8E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.1E-02	1.1E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.1E-02	2.3E-02	2.3E-02	4.1E-02	3.5E-04	2.3E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.1E-05	1.4E-03	1.4E-03	2.8E-03	7.4E-01	1.4E-03	4.7E-01	4.6E-02	2.4E-01	3.4E+00	3.4E-04
>7-8 Aromatics	3.1E-05	7.0E-06	7.0E-06	6.3E-05	1.3E-02	8.5E-06	4.8E-03	4.6E-04	4.4E-04	2.4E-02	8.8E-06
>8-10 Aromatics	2.6E-02	2.8E-02	2.8E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.8E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.1E-02	5.7E-02	5.7E-02	2.1E-01	1.3E-02	6.1E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.5E-01	1.5E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.2E-02	1.2E-01	2.5E-04	2.4E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		**9.11E+04**	**5.76E+03**	**5.10E+11**	**5.01E+08**	**5.29E+03**	**3.55E+05**	**5.12E+02**	**8.55E+03**	**8.68E+08**	**9.26E+00**
RBSL(C_{TPH}) (mg/kg)		**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**400000**	**500**	**9000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-32 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP010-06

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.0056	0.0056	5.82E-03	7.46E-05	1.44E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.11	0.055	5.71E-02	2.51E-04	4.83E-02
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.17	0.085	8.83E-02	3.50E-04	6.75E-02
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.26	0.13	1.35E-01	5.36E-04	1.03E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.086	0.043	4.47E-02	1.77E-04	3.41E-02
218-01-9	Chrysene	2.28E+02	<	0.11	0.055	5.71E-02	2.51E-04	4.83E-02
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.4	0.2	2.08E-01	7.47E-04	1.44E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.13	0.065	6.75E-02	2.45E-04	4.71E-02
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.25	0.125	1.30E-01	1.60E-03	3.09E-01
	C>6-C8 aliphatics	1.00E+02	<	0.25	0.125	1.30E-01	1.30E-03	2.50E-01
	C>8-C10 aliphatics	1.30E+02	<	5	2.5	2.60E+00	2.00E-02	3.85E+00
	C>10-C12 aliphatics	1.60E+02	<	10	5	5.19E+00	3.25E-02	6.25E+00
	C>12-C16 aliphatics	2.00E+02	<	25	12.5	1.30E+01	6.49E-02	1.25E+01
	C >16-C21aliphatics	2.70E+02	<	25	12.5	1.30E+01	4.81E-02	9.26E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.12E-03	4.00E-05	7.70E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.12E-03	3.38E-05	6.52E-03
	C >8 - C10 aromatics	1.20E+02	<	5	2.5	2.60E+00	2.16E-02	4.17E+00
	C>10-C12 aromatics	1.30E+02	<	10	5	5.19E+00	4.00E-02	7.70E+00
	C>12-C16 aromatics	1.50E+02	<	25	12.5	1.30E+01	8.66E-02	1.67E+01
	C>16-C21 aromatics	1.90E+02	<	25	12.5	1.30E+01	6.83E-02	1.32E+01
	C>21-C35 aromatics	2.40E+02	<	62	31	3.22E+01	1.34E-01	2.58E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	32.75	100	
aromatics	63.506		
Total	96.256		

(LOCATION): HP010-06
Commercial Receptor

Table A-33:TPHCWG Demonstration, AF Plant 6 Fuel Farm

TPH Fraction Risk-Based Screening Levels (RBSLs)

	$C_{i,sat}$ TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC

Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)

	Weight Fraction (f_i) (mg/kg/mg/kg)	Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.4E-04	3.5E-03	8.4E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.6E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.2E-02	1.2E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.2E-02	2.3E-02	2.3E-02	4.2E-02	3.5E-04	2.4E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.1E-05	1.4E-03	1.4E-03	2.8E-03	7.4E-01	1.4E-03	4.7E-01	4.5E-02	2.3E-01	3.4E+00	3.4E-04
>7-8 Aromatics	3.1E-05	6.9E-06	6.9E-06	6.2E-05	1.3E-02	8.5E-06	4.8E-03	4.6E-04	4.3E-04	2.4E-02	8.6E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.8E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.2E-02	5.8E-02	5.8E-02	2.1E-01	1.3E-02	6.2E-02	3.1E-02	8.7E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.1E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00

TPH Risk Based Screening Levels

		Surface Soil Ingestion	Surface Soil Dermal	Fugitive Dust Inhalation	Surface soil Outdoor vapor Inhalation	Surface soil Soil, Dust, Vapor Combined	Subsurface soil Outdoor vapor Inhalation	Subsurface soil Indoor vapor Inhalation	Subsurface soil Leaching to gw Ingestion	Groundwater Outdoor vapor Inhalation	Groundwater Indoor vapor Inhalation
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		**9.11E+04**	**5.77E+03**	**5.08E+11**	**5.01E+08**	**5.29E+03**	**3.56E+05**	**5.05E+02**	**8.45E+03**	**8.68E+08**	**9.11E+00**
RBSL(C_{TPH}) (mg/kg)		**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**400000**	**500**	**8000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

Sample Identification Data

TPHCWG Demonstration, AF Plant 6 Fuel Farm
Table A-34 (Composition Data)

(MM/DD/YR): 09/20/01
(TYPE): Soil
(SITE NAME): AF Plant 6 Fuel Farm
(LOCATION): HP011-06

CAS #	COMPOUND	Molecular Weight (g/mol)	Soil Data (mg/kg)		Calculation (.5* det. Lim.)	Weight percent	(mol/g)	Mole Percent
	Volatile Organic Compounds							
71-43-2	Benzene	7.80E+01		0.012	0.012	1.30E-02	1.66E-04	3.20E-02
	Carcinogenic PAHs							
56-55-3	Benz(a)anthracene	2.28E+02	<	0.39	0.195	2.11E-01	9.24E-04	1.78E-01
50-32-8	Benzo(a)pyrene	2.52E+02	<	0.39	0.195	2.11E-01	8.36E-04	1.61E-01
205-99-2	Benzo(b)fluoranthene	2.52E+02	<	0.39	0.195	2.11E-01	8.36E-04	1.61E-01
207-08-9	Benzo(k)fluoranthene	2.52E+02	<	0.39	0.195	2.11E-01	8.36E-04	1.61E-01
218-01-9	Chrysene	2.28E+02	<	0.39	0.195	2.11E-01	9.24E-04	1.78E-01
53-70-3	Dibenz(ah)anthracene	2.78E+02	<	0.39	0.195	2.11E-01	7.58E-04	1.46E-01
193-39-5	Indeno(123-cd)pyrene	2.76E+02	<	0.39	0.195	2.11E-01	7.63E-04	1.47E-01
	TPH fractions							
	C>5-C6 aliphatics	8.10E+01	<	0.24	0.12	1.30E-01	1.60E-03	3.09E-01
	C>6-C8 aliphatics	1.00E+02	<	0.24	0.12	1.30E-01	1.30E-03	2.50E-01
	C>8-C10 aliphatics	1.30E+02	<	4.8	2.4	2.59E+00	1.99E-02	3.85E+00
	C>10-C12 aliphatics	1.60E+02	<	9.5	4.75	5.13E+00	3.21E-02	6.18E+00
	C>12-C16 aliphatics	2.00E+02	<	24	12	1.30E+01	6.48E-02	1.25E+01
	C >16-C21aliphatics	2.70E+02	<	24	12	1.30E+01	4.80E-02	9.26E+00
	C>5-C7 aromatics	7.80E+01	<	0.006	0.003	3.24E-03	4.16E-05	8.01E-03
	C>7-C8 aromatics	9.21E+01	<	0.006	0.003	3.24E-03	3.52E-05	6.79E-03
	C >8 - C10 aromatics	1.20E+02	<	4.8	2.4	2.59E+00	2.16E-02	4.17E+00
	C>10-C12 aromatics	1.30E+02	<	9.5	4.75	5.13E+00	3.95E-02	7.61E+00
	C>12-C16 aromatics	1.50E+02	<	24	12	1.30E+01	8.64E-02	1.67E+01
	C>16-C21 aromatics	1.90E+02	<	24	12	1.30E+01	6.82E-02	1.32E+01
	C>21-C35 aromatics	2.40E+02	<	60	30	3.24E+01	1.35E-01	2.60E+01

Total TPH fractions		*Sum of weight %*	5.19E-01
aliphatics	31.39	100	
aromatics	61.156		
Total	92.546		

(LOCATION): HP011-06
Commercial Receptor

Table A-35:TPHCWG Demonstration, AF Plant 6 Fuel Farm

	C_{sat} TPH fractions (i) (mg/kg)	Surface Soil Ingestion (mg/kg)	Surface Soil Dermal (mg/kg)	Fugitive Dust Inhalation (mg/kg)	Surface soil Outdoor vapor Inhalation (mg/kg)	Surface soil Soil, Dust, Vapor Combined (mg/kg)	Subsurface soil Outdoor vapor Inhalation (mg/kg)	Subsurface soil Indoor vapor Inhalation (mg/kg)	Subsurface soil Leaching to gw Ingestion (mg/kg)	Groundwater Outdoor vapor Inhalation (mg/L)	Groundwater Indoor vapor Inhalation (mg/L)
		TPH Fraction Risk-Based Screening Levels (RBSLs)									
>5-6 Aliphatics	4.7E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	4.1E+03	6.1E+01	8.1E+04	1.0E+04	1.4E+01
>6-8 Aliphatics	2.6E+02	1.0E+07	6.5E+05	1.2E+13	4.5E+06	5.4E+05	9.8E+03	1.5E+02	2.9E+05	6.8E+03	9.3E+00
>8-10 Aliphatics	1.4E+02	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	2.3E+03	3.4E+01	4.1E+04	2.3E+02	3.2E-01
>10-12 Aliphatics	8.6E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	1.2E+04	1.8E+02	3.1E+05	1.5E+02	2.1E-01
>12-16 Aliphatics	3.8E+01	2.0E+05	1.3E+04	6.3E+11	2.4E+05	1.2E+04	5.4E+04	8.1E+02	6.2E+06	3.6E+01	4.9E-02
>16-21 Aliphatics	1.6E+01	4.1E+06	2.6E+05	No RfC	No RfC	2.4E+05	No RfC	No RfC	1.6E+10	No RfC	No RfC
>5-7 Aromatics	1.6E+03	2.0E+03	1.3E+02	5.7E+09	2.2E+03	1.2E+02	2.3E+01	3.5E-01	1.1E+00	5.2E+02	8.4E-01
>7-8 Aromatics	1.3E+03	4.1E+05	2.6E+04	2.5E+11	9.7E+04	1.9E+04	2.3E+03	3.4E+01	6.1E+02	2.1E+04	3.3E+01
>8-10 Aromatics	1.0E+03	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	3.7E+03	5.6E+01	7.9E+02	6.1E+03	8.9E+00
>10-12 Aromatics	6.3E+02	8.2E+04	5.2E+03	1.3E+11	4.9E+04	4.4E+03	2.0E+04	3.0E+02	1.2E+03	1.4E+04	2.4E+01
>12-16 Aromatics	2.9E+02	8.2E+04	5.2E+03	1.3E+11	6.4E+04	4.5E+03	1.1E+05	1.6E+03	2.5E+03	2.3E+04	5.1E+01
>16-21 Aromatics	1.0E+02	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	5.9E+03	No RfC	No RfC
>21-35 Aromatics	8.3E+00	6.1E+04	3.9E+03	No RfC	No RfC	3.7E+03	No RfC	No RfC	4.7E+04	No RfC	No RfC
	Weight Fraction (f_i) (mg/kg/mg/kg)	**Hazard Quotients (HQ_i) for fractions that are calculated iteratively to obtain TPH RBSLs (unitless)**									
>5-6 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	1.0E-04	1.3E-05	1.1E-01	1.1E-02	1.3E-04	3.5E-03	8.4E-04
>6-8 Aliphatics	1.3E-03	1.2E-05	1.2E-05	5.7E-05	5.7E-05	1.3E-05	2.6E-02	4.5E-03	3.7E-05	7.9E-04	1.3E-03
>8-10 Aliphatics	2.6E-02	1.2E-02	1.2E-02	2.1E-02	5.8E-04	1.2E-02	6.1E-02	3.8E-01	3.5E-03	1.9E-03	7.5E-01
>10-12 Aliphatics	5.1E-02	2.3E-02	2.3E-02	4.1E-02	3.5E-04	2.3E-02	7.3E-03	1.5E-01	2.7E-04	2.2E-04	1.6E-01
>12-16 Aliphatics	1.3E-01	5.8E-02	5.8E-02	1.0E-01	1.6E-04	5.9E-02	7.0E-04	4.7E-02	6.1E-06	2.1E-05	1.6E-02
>16-21 Aliphatics	1.3E-01	2.9E-03	2.9E-03	0.0E+00	0.0E+00	2.8E-03	0.0E+00	0.0E+00	1.0E-09	0.0E+00	0.0E+00
>5-7 Aromatics	3.2E-05	1.4E-03	1.4E-03	2.9E-03	7.4E-01	1.5E-03	4.8E-01	4.7E-02	2.4E-01	3.4E+00	3.5E-04
>7-8 Aromatics	3.2E-05	7.2E-06	7.2E-06	6.5E-05	1.3E-02	8.8E-06	4.8E-03	4.8E-04	4.5E-04	2.4E-02	9.0E-06
>8-10 Aromatics	2.6E-02	2.9E-02	2.9E-02	1.0E-01	2.1E-02	3.1E-02	2.8E-01	2.3E-01	2.8E-01	1.1E-02	2.6E-02
>10-12 Aromatics	5.1E-02	5.7E-02	5.7E-02	2.1E-01	1.3E-02	6.1E-02	3.1E-02	8.6E-02	3.5E-01	1.8E-03	1.9E-02
>12-16 Aromatics	1.3E-01	1.4E-01	1.4E-01	5.2E-01	4.6E-03	1.5E-01	2.7E-03	4.1E-02	1.2E-01	2.5E-04	2.3E-02
>16-21 Aromatics	1.3E-01	1.9E-01	1.9E-01	0.0E+00	0.0E+00	1.9E-01	0.0E+00	0.0E+00	1.8E-02	0.0E+00	0.0E+00
>21-35 Aromatics	3.2E-01	4.8E-01	4.8E-01	0.0E+00	0.0E+00	4.7E-01	0.0E+00	0.0E+00	1.8E-04	0.0E+00	0.0E+00
Total	1.0E+00										
Hazard Index (HI) (ΣHQ_i)		1.0E+00	1.0E+00	1.0E+00	8.0E-01	1.0E+00	1.0E+00	1.0E+00	1.0E+00	3.5E+00	1.0E+00
		TPH Risk Based Screening Levels									
		(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Total TPH (mg/kg)		**9.10E+04**	**5.76E+03**	**5.10E+11**	**5.01E+08**	**5.29E+03**	**3.45E+06**	**5.06E+02**	**8.40E+03**	**8.68E+08**	**9.12E+00**
RBSL(C_{TPH}) (mg/kg		**90000**	**6000**	**5E+11**	**>Csat**	**5000**	**300000**	**500**	**8000**	**900000000**	**9**

Pathways:

surface soil ingestion = incidental ingestion of surficial soil
surface soil dermal = dermal contact with surficial soil
fugitive dust inhalation = inhalation of dust from surface soil
surface soil outdoor vapor inhalation = outdoor inhalation of vapors from surficial soil
surface soil indoor vapor inhalation = indoor inhalation of vapors from surficial soil
surface soil ingest, dermal, inhal = combined incidential ingestion, inhalation of dust, and outdoor inhalation of vapors from surficial soil
subsurface soil outdoor vapor inhalation =outdoor inhalation of vapors from subsurface soil
subsurface indoor vapor inhalation =indoor inhalation of vapors from subsurface soil
gw outdoor vapor inhalation = outdoor inhalation of vapors from groundwater
gw indoor vapor inhalation =indoor inhalation of vapors from groundwater
gw ingestion = ingestion of groundwater
subsurface soil leaching to gw ingestion = ingestion of groundwater that contains contaminants leaching from subsurface soil

APPENDIX B

RBSL CALCULATIONS

The procedure for calculating a TPH RBSL for cross-media pathways based upon summing the risk from each fraction is complex. Please note that the following procedure is only appropriate for calculation of RBSLs for cross-media pathways since it sets as an upper limit for the RBSL the degree of saturation, which does not limit exposure for direct routes such as soil ingestion, dermal exposure, and inhalation of particulates. An additional procedure used to calculate exposure for direct pathways is also provided.

CROSS-MEDIA PATHWAYS

Partitioning qualities govern how a chemical interacts with its environment. Specific physical properties responsible include solubility, vapor pressure, sorption coefficient and Henry's Law Constant. A brief discussion of the role these parameters play in basic partitioning in the environment is provided in the following paragraphs. The fraction-specific values for each of the described fate and transport parameters is provided in Table B-1. The equations used to develop these fate and transport properties are available in the TPH Criteria Working Group "Volume III. Selection of Representative TPH Fractions Based on Fate and Transport Considerations" (1997).

The solubility of aromatic hydrocarbons, for any EC number, is generally greater than that of aliphatic hydrocarbons, especially at high EC values. The variability in solubility around any given EC value is about an order of magnitude. The higher solubility of the aromatics means that aromatic hydrocarbons are more likely to be present as dissolved constituents in groundwater than are the corresponding aliphatic hydrocarbons.

The soil-water sorption coefficient (k_s) expresses the tendency of a chemical to be adsorbed onto a soil particle. The magnitude of the sorption coefficient for most soil/water systems is a function of the hydrophobicity of the chemical (as indicated by its solubility) and the organic carbon content of the soil. For non-ionic, hydrophobic chemicals such as petroleum hydrocarbons, the primary property controlling sorption is the organic carbon content (f_{oc}) of the soil.

In general, aliphatic fractions are more likely to remain bound to a soil particle than the aromatic fraction of an equivalent EC. This tendency was previously indicated by the low solubility observed for aliphatic fractions. The majority of log k_{oc} (carbon-water sorption coefficient) values presented in Table B-1 were derived from the octanol-water partitioning coefficient (k_{ow}).

There is very little difference in vapor pressure between aliphatic and aromatic constituents of an equivalent EC. In effect, the EC and vapor pressure are closely related. This relationship is expected because both EC and vapor pressure are largely functions of a compound's boiling point.

Table B-1: Hydrocarbon Fractions and Associated Properties

TPH Fractions	Solubility (mg/L)	Henry's Constant (dimensionless)	Vapor Pressure (atm)	Log K_{oc} (c/c)	BP (°C)	MW (g/mole)
Aliphatic						
EC5-6	28	33	0.5	2.9	51	81
EC>6-8	4.2	50	0.85	3.6	96	100
EC>8-10	0.33	80	0.0081	4.5	150	130
EC>10-12	0.026	120	7.8E-4[c]	5.4	200	160
EC>12-16	5.9E-4	520	3.5E-5	6.7	260	200
EC>16-21	1.0E-6	4,900	1.7E-6	8.8	320	270
Aromatic						
EC5-7[a]	18	0.23	0.13	1.9	80	78
EC>7-8[b]	520	0.27	0.038	2.4	110	92
EC>8-10	65	0.48	0.0081	3.2	150	120
EC>10-12	25	0.14	7.8E-4	3.4	200	130
EC>12-16	5.8	0.053	3.5E-5	3.7	260	150
EC>16-21	0.51	0.013	1.7E-6	4.2	320	190
EC>21-35	0.0066	6.7E-4	7.9E-9	5.1	340	240

[a] (Benzene)
[b] (Toluene)
[c] (scientific notation, 7.8×10^{-4})
EC = equivalent carbon number
BP = boiling point
MW = molecular weight
Note: Values are based on pure compounds; behavior may differ in complex mixtures.

The Henry's law constant (H_c) is definable as an air-water partitioning coefficient and may be measured as the ratio of a compound's concentration in air to its concentration in water at equilibrium. Aliphatics and aromatics behave differently based on Henry's law constant. For aromatic fractions, the Henry's law constant mostly decreases with increasing EC; for aliphatic fractions, the Henry's law constant increases with increasing EC. In general, aliphatic hydrocarbons are less soluble and more volatile than aromatic hydrocarbons. It is important to note, however, that benzene, an aromatic compound, is very volatile and more toxic than the corresponding aliphatic fractions. Therefore, when present, benzene is likely to drive risk calculations for pathways involving volatilization from soil or groundwater.

The parameters described above are combined into simple fate and transport models to evaluate the partitioning and migration of chemicals for the different applicable pathways. For leaching and volatilization pathways where transport and therefore exposure are maximized at the saturation concentration for specific fractions, the following equations are solved. These three equations were adapted from Volume 5 of the Working Group's publications (TPHCWG, 1999).

$$HI = \sum_{i=1}^{i=n} HQ_i = \sum Min\left(\frac{f_i C_{TPH}}{RBSL_i}, \frac{C_{sat,i}}{RBSL_i}\right) \leq 1 \quad \text{given,} \qquad \text{(Equation B-1)}$$

$$\sum_{i=1}^{i=13} f_i = \sum \frac{C_i}{C_{TPH}} = 1 \qquad \text{(Equation B-2)}$$

where:

HI	=	Hazard Index (typically ≤ 1) [unitless]
n	=	number of fractions (13 total) [unitless]
HQ_i	=	Hazard Quotient for Ith TPH fraction [unitless]
f_i	=	Percent Weight of ith TPH fraction in total TPH mixture [unitless]
C_I	=	Concentration of Ith TPH fraction in total TPH mixture [unitless]
C_{TPH}	=	Concentration of TPH mixture
$C_{sat,i}$	=	Saturation concentration for ith TPH fraction (mg/kg)
$RBSL_i$	=	Tier 1 risk-based screening level for ith TPH fraction (mg/kg)

The saturation concentration is defined by Equation B-3:

$$C_{sat,i}[mg/kg] = \frac{S_i}{\rho_s}\left[H_{c,i}\theta_{as} + \theta_{ws} + k_{s,i}\rho_s\right] \qquad \text{(Equation B-3)}$$

where:

S_i	=	Fraction effective solubility [mg/L]
ρ_s	=	Soil Bulk Density [g/cm^3]
$H_{c,i}$	=	Henry's Constant for ith TPH fraction [atm-m^3/mol]
θ_{as}	=	Volumetric air content of the soil [cm^3/cm^3]
θ_{ws}	=	Volumetric water content of the soil [cm^3/cm^3]
$k_{s,i}$	=	Soil sorption coefficient for ith TPH fraction (k_{oc}*f_{oc}) [cm^3/g]

Note: The effective solubility of a hydrocarbon fraction is equal to the fraction's solubility limit multiplied by the mole fraction of the hydrocarbon fraction in the mixture (i.e., TPH).

The value obtained for C_{sat} will vary considerably if the effective C_{sat} of each fraction present in the sample is considered through the use of Raoult's law. Equations B1 through B3 are iteratively solved for each TPH fraction, which is the additive mixture RBSL for the soil sample. Residual saturation is the point at which any increase in chemical concentration will not change the risk, up until the point at which free product migration becomes an issue. For purposes of comparing RBSLs obtained using different analytical fractionation methods, such as the MADEP TPH Method, Raoult's law was not used to calculate the RBSLs presented in the following sections.

Soil Leaching to Groundwater Pathway

Leaching of contaminants from impacted soil into groundwater through infiltrating water is one exposure pathway evaluated in the RBCA analysis. Soil RBSLs are calculated to be protective of groundwater quality. This involves: 1) calculating a groundwater RBSL ($RBSL_{gw}$) to determine an acceptable water concentration, 2) calculating a leachate concentration protective of groundwater (based on the groundwater RBSL), and 3) calculating a soil concentration which would result in this leachate concentration. Equation B4 (adapted from ASTM, 1995) calculates the ingestion $RBSL_{gw}$ for each TPH fraction. The $RBSL_{gw}$ is based on a target hazard quotient of 1.0. Exposure parameters are provided in Table B-2. RfDs for the fractions are listed in Table B-3.

$$RBSL_{gw,i}\left[\frac{mg}{L-water}\right]=\frac{THQ\times RfD_{o,i}\times BW\times AT_n\times 365\,{}^{days}\!/\!_{yr}}{IR_{water}\times EF\times ED} \qquad \text{(Equation B-4)}$$

where:

THQ	=	Target hazard quotient [unitless] = 1
$RfD_{o,i}$	=	Oral chronic reference dose for i^{th} TPH fraction [mg/kg-day]
BW	=	Body weight [kg]
AT_n	=	Averaging time for noncarcinogens [yrs]
IR_{water}	=	Daily ingestion rate [L/day]
EF	=	Exposure frequency [days/yr]
ED	=	Exposure Duration [yrs]

TABLE B-2 Tier 1 Default Exposure Factors

Name	Parameter	Units	Recreational Scenario	Commercial Scenario
Averaging Time: non-carcinogens	AT_n	y	25	25
Body Weight	BW	kg	70	70
Exposure Duration	ED	y	30	25
Exposure Frequency	EF	days/y	45	250
Ingestion rate: soil	IR_{soil}	mg/day	50	50
Inhalation Rate: air-indoor	IR_{air-in}	m^3/day	20	20
Inhalation Rate: air-outdoor	$IR_{air-out}$	m^3/day	20	20
Ingestion rate: water	IR_{water}	L/day	0.05	1
Soil Adherence Factor	M	mg/cm^2	0.5	0.5
Dermal Absorption Factor	$RAF_{d,i}$	-	c.s.	c.s.
Oral Absorption Factor	RAF_o	-	1	1
Skin surface area	SA	cm^2/day	3160	3160
Target Hazard Quotient for Individual Constituents.	THQ	-	1	1

Notes: c.s. = chemical specific, ED, EF, and IR_{water} for recreational exposure scenario were extracted from http://risk.1sd.ornl.gov/homepage/tm/for_rec_wa.shtml. All other exposure factors for recreational scenario have been set equal to the commercial scenario factors as shown in the above table.

The analytical model used to estimate soil leaching to groundwater determines the partitioning of a constituent into water, vapor and sorbed phases based on the physical and chemical properties of the constituent. In this model, infiltrating water migrates through contaminated soils in the vadose zone. At this point, some of the contaminant partitions from the soil or vapor transfer into the water phase. This leachate is then assumed to migrate completely and instantaneously into groundwater. Some dilution of the leachate is included using an attenuation factor based on infiltration rate, groundwater velocity, source width and height of the mixing zone in the water column. Equation B-5 describes this attenuation factor (AF).

Table B-3: TPHCWG Toxicity Fraction-Specific RfDs (mg/kg/day)

Carbon Range	Aromatic RfD	Critical Effect	Aliphatic RfD	Critical Effect
EC5-6 EC7-8	0.20 – Oral 0.10 – Inhalation	Hepatotoxicity, Nephrotoxicity	5.0 – Oral 5.0 – Inhalation	Neurotoxicity
EC9-10 EC11-12 EC13-16	0.04 – Oral 0.05 – Inhalation	Decreased body weight	0.1 – Oral 0.3 – Inhalation	Hepatic and hematological changes
EC17-21 EC22-34	0.03	Nephrotoxicity	1.00	Hepatic (foreign body reaction) granuloma

$$AF = \left[1 + \frac{U_{gw}\delta_{gw}}{IW}\right] \quad \text{(Equation B-5)}$$

where:

U_{gw} = Groundwater velocity [ft/day]
δ_{gw} = Height of groundwater mixing zone [ft]
I = Precipitation infiltration rate [ft/day]
W = Width of the source area parallel to the mixing zone [ft]

Partitioning into the three phases, soil, water and air, is governed by the partitioning factor. As Henry's law constant is applicable only to dilute solutions, the use of this model is not appropriate when free phase liquid is present. The partitioning factor (PF) for each TPH fraction is shown in Equation B-6.

$$PF_i = \frac{\lfloor \theta_{ws} + k_{s,i}\rho_s + H_{c,i}\theta_{as} \rfloor}{\rho_s} \quad \text{(Equation B-6)}$$

where,

θ_{ws}	=	Soil volumetric water content [cm^3/cm^3]
$k_{s,i}$	=	Soil sorption coefficient (k_{oc}*f_{oc}) for i^{th} TPH fraction [cm^3/g]
ρ_s	=	Soil density [g/cm^3]
$H_{c,i}$	=	Henry's Constant for i^{th} TPH fraction [$atm\text{-}m^3/mol$]
θ_{as}	=	Soil volumetric air content [cm^3/cm^3]

The inverse of the product of PF multiplied by AF, which accounts for dilution of leached water into underlying groundwater, is termed the soil to water leaching factor (LF_{sw}). The ultra-conservative leaching model assumes that no attenuation of leachate occurs from the vadose to the saturated zone. In fact, biological degradation of the constituent or repartitioning onto soil or into the vapor phase are all likely to occur as the leachate migrates to groundwater. Other assumptions of the model include: 1) a constant chemical concentration in the subsurface soils, 2) linear equilibrium partitioning within the soil matrix between sorbed, dissolved and vapor phases, 3) steady-state leaching from the vadose zone to groundwater, and 4) steady state, well-mixed dispersion of the leachate within the groundwater mixing zone. Therefore the LF_{sw}, which governs the movement of contaminants from soil to infiltrating water, incorporates both the PF and the AF, in Equation B-7:

$$LF_{sw,i} = \frac{\rho_s}{\left[\theta_{ws} + k_{s,i} + H_{c,i}\theta_{as}\right]\left(1 + \frac{U_{gw}\delta_{gw}}{IW}\right)}$$

(Equation B-7)

where:

$LF_{sw,i}$	=	leaching factor for i^{th} TPH fraction [$mg/L\text{-}H_2O$ / mg/kg-soil]
ρ_s	=	Soil Bulk Density [g/cm^3]
θ_{ws}	=	Soil volumetric water content [cm^3/cm^3]
$k_{s,i}$	=	Soil sorption coefficient (k_{oc}*f_{oc}) for i^{th} TPH fraction [cm^3/g]
$H_{c,i}$	=	Henry's Constant for i^{th} TPH fraction [$atm\text{-}m^3/mol$]
θ_{as}	=	Soil volumetric air content [cm^3/cm^3]
U_{gw}	=	Groundwater Darcy velocity [ft/day]
δ_{gw}	=	Height of groundwater mixing zone [ft]
I	=	Precipitation infiltration rate [ft/day]
W	=	Width of source area parallel to wind direction [cm]

Parameters for cross-media pathways are provided in Table B-4. Equations B-5 through B-8 were adapted from ASTM's risk-based corrective action (RBCA) standard guide (1995). Once the LF has been established, fraction-specific soil RBSLs may be calculated as follows:

$$RBSL_{s,i}\left[\frac{mg}{kg-soil}\right] = \frac{RBSL_{gw,i}\left[\frac{mg}{L-air}\right]}{LF_{sw,i}} \qquad \text{(Equation B-8)}$$

Volatilization to Indoor Air Pathway

The mathematical model used to estimate volatilization from soil to indoor air is based upon the partitioning of a constituent into water, vapor and sorbed phases as determined by the physical properties of the chemical. The model accounts for the contaminant partitioning into soil pore gas and migrating through the vadose zone to the base of a building foundation. From there the gas diffuses through cracks in the foundation and into the building air space, where exposure through inhalation may occur.

The first step in calculating a soil RBSL for the indoor air pathway requires the calculation of an air concentration or RBSL, which is protective of indoor air quality (based on a target HQ of 1.0). Indoor air RBSLs are calculated for each TPH fraction and then a whole TPH RBSL is calculated based on the percent composition of each fraction. Equation B-9 is used to calculate the air RBSLs for TPH fractions. Parameter values are presented in Table B-4.

TABLE B-4 Parameters for Cross-Media RBSL Calculations

Description	Parameter	Units	Tier 1 Default Values
Ambient air mixing zone height	δ_{air}	cm	200
Areal fraction of cracks in foundations/walls	η	cm^2/cm^2	0.01
Depth to subsurface soil sources	L_S	cm	100
Diffusion coefficient in air	D^{air}_i	cm^2/s	c.s.
Diffusion coefficient in water	D^{wat}_i	cm^2/s	c.s.
Enclosed space air exchange rate	ER	1/s	0.00023
Enclosed space foundation or wall thickness	L_{crack}	cm	15
Enclosed space volume/infiltration area ratio	$L_{B,i}$	cm	300
Fraction of organic carbon in soil	f_{oc}	cm^3/cm^3	0.01
Groundwater Darcy velocity	U_{gw}	cm/yr	2500
Groundwater mixing zone thickness	δ_{gw}	cm	200
Henry's Law Constant	$H_{c,i}$	(cm^3/cm^3)	c.s.
Infiltration rate of water through soil	I	cm/yr	30
Particulate Emission Rate	$VF_{p,i}$	$\frac{(mg/m^3)}{(mg/kg)}$	6.9×10^{-14}
Soil bulk density	ρ_S	g/cm^3	1.7
Soil-water sorption coefficient	$k_{s,i}$	cm^3/g	$f_{oc} \times k_{oc}$
Total soil porosity	θ_T	cm^3/cm^3	0.38
Volatilization Factor (Vapor Emission Rate)	$VF_{ss,i}$	$\frac{(mg/m^3)}{(mg/m^3)}$	0.26
Volumetic air content in vadose zone soils	θ_{as}	cm^3/cm^3	0.26
Volumetric air content in foundation cracks	θ_{acrack}	cm^3/cm^3	0.26
Volumetric water content vadose zone soils	θ_{ws}	cm^3/cm^3	0.12
Volumetric water content: foundation cracks	θ_{wcrack}	cm^3/cm^3	0.12
Width of source area parallel to flow direction	W	cm	1500
Wind speed above ground surface	U_{air}	cm/s	225

Notes: c.s. = chemical specific
m.s. = media specific

Commercial/Industrial Scenario

$$RBSL_{air,i}\left[\frac{\mu g}{m^3 air}\right]=\frac{THQ\times RfD_{i,i}\times BW\times AT_n\times 365\,{}^{days}\!/_{yr}\times 10^3\,{}^{\mu g}\!/_{mg}}{IR_{air}\times EF\times ED}$$

(Equation B-9)

where:

THQ	=	Target hazard quotient [unitless] = 1
$RfD_{i,i}$	=	Inhalation chronic reference dose for ith TPH fraction [mg/kg-day]
BW	=	Body weight [kg]
AT_n	=	Averaging time for noncarcinogens [yrs]
IR_{air}	=	Daily inhalation rate [m^3/day]
EF	=	Exposure frequency [days/yr]
ED	=	Exposure Duration [years]

The second step in calculating a soil concentration ($RBSL_{soil}$) which will result in an acceptable indoor air concentration ($RBSL_{air}$) is to model the transport of contaminants from the vadose soil to indoor air. This model is extremely conservative, assuming: 1) a constant chemical concentration in subsurface soils; 2) linear equilibrium partitioning in the soil between sorbed, dissolved and vapor phases; and 3) steady-state vapor- and liquid-phase diffusion through the vadose zone and foundation cracks. In addition, the model assumes that vapors migrate completely and instantaneously into the building, i.e., no attentuation occurs. It does not account for any biodegradation and soil sorption which could occur as the vapor migrates through the vadose zone.

Dilution of vapor is expected to occur between the source and the building. Therefore the following diffusion coefficient in soil (D^{eff}_s) for each TPH fraction is used (see Equation B-10).

$$D^{eff}_{s,i}\left[\frac{cm^2}{s}\right]=D^{air}_i\,\frac{\theta_{as}^{3.33}}{\theta_T^2}+D^{wat}_i\,\frac{1}{H_{c,i}}\times\frac{\theta_{ws}^{3.33}}{\theta_T^2}\qquad \text{(Equation B-10)}$$

where:

D^{air}_i	=	Diffusion coefficient in air for ith TPH fraction [cm^2/sec]
θ_{as}	=	Soil volumetric air content [cm^3-air/cm^3-soil]
θ_T	=	Total soil porosity [cm^3/cm^3]
D^{wat}_i	=	Diffusion coefficient in water for ith TPH fraction [cm^2/sec]
$H_{c,i}$	=	Henry's constant for ith TPH fraction [cm^3-air/cm^3-soil]
θ_{ws}	=	Soil volumetric water content [cm^3-water/cm^3-soil]

The diffusion of the pore gas through cracks in the foundation is governed by Equation B-11. Equations B-9 through B-11 were adapted from ASTM RBCA (1995).

$$D^{eff}_{crack,i}\left[\frac{cm^2}{s}\right] = D_i^{air}\frac{\theta^{3.33}_{acrack}}{\theta_T^2} + D_i^{wat}\frac{1}{H_{c,i}}\times\frac{\theta^{3.33}_{wcrack}}{\theta_T^2} \qquad \text{(Equation B-11)}$$

where:

D^{air}_i = Diffusion coefficient in air for i^{th} TPH fraction [cm^2/sec]
θ_{acrack} = Volumetric air content in foundation [cm^3-air/cm^3]
θ_T = Total soil porosity [cm^3/cm^3]
D^{wat}_i = Diffusion coefficient in water for i^{th} TPH fraction [cm^2/sec]
$H_{c,i}$ = Henry's constant for i^{th} TPH fraction [cm^3-air/cm^3-soil]
θ_{wcrack} = Volumetric water content in foundation [cm^3-water/cm^3]

Chemical Partitioning

Equation B-12 accounts for the movement of chemicals from the soil into the vapor phase of the soil pore space. This is defined as the partitioning factor (soil/vapor phase) and is fraction specific.

$$PF_{s-v,i} = \frac{H_{c,i}\rho_s}{\theta_{ws} + k_{s,i}\rho_s + H_{c,i}\theta_{as}} \qquad \text{(Equation B-12)}$$

where:

$PF_{s-v,i}$ = Soil/Vapor phase partitioning factor for i^{th} TPH fraction [unitless]
$H_{c,i}$ = Henry's Constant for i^{th} TPH fraction [cm^3-water/cm^3-air]
ρ_s = Soil bulk density [g/cm^3]
θ_{ws} = Soil volumetric water content [cm^3/cm^3]
$k_{s,i}$ = Soil sorption coefficient (k_{oc}*f_{oc}) for i^{th} TPH fraction [cm^3/g]
θ_{as} = Soil volumetric air content [cm^3/cm^3]

The diffusion coefficients and partitioning factor are combined to yield a subsurface soil to enclosed space volatilization factor (VF_{sesp}) for each TPH fraction. VF_{sesp} takes into account partitioning, diffusion in the vadose zone, effective diffusion into an enclosed space and adds terms for accumulation of vapors in the enclosed space (see Equation B-13).

$$VF_{sesp,i} = \frac{(PF_{s-v,i})\dfrac{D^{eff}_{s,i}/L_s}{ER\times L_B}}{1+\dfrac{D^{eff}_{s,i}/L_s}{ER\times L_B}+\dfrac{D^{eff}_{s,i}+L_s}{(D^{eff}_{crack,i}/L_{crack})\times\eta}}\times 10^3\left[\frac{cm^3-kg}{m^3-g}\right] \qquad \text{(Equation B-13)}$$

where:

$PF_{s-v,i}$ = Soil/Vapor phase partitioning factor for i^{th} TPH fraction [unitless]
$D^{eff}_{s,i}$ = Effective diffusion coefficient in soil for i^{th} TPH fraction [cm^2/s]

L_s = Depth to subsurface soil sources [cm]
ER = Enclosed-space air exchange rate [s^{-1}]
L_B = Enclosed-space volume/infiltration area ratio [cm]
$D^{eff}_{crack,i}$= Effective diffusion coefficient through foundation cracks for i^{th} TPH fraction [cm^2/s]
L_{crack} = Enclosed-space foundation or wall thickness [cm]
η = Areal fraction of cracks in foundation/walls [cm^2/cm^2]

Values in these calculations are provided in Table B-4. The term VF_{sesp}, when combined with the allowable concentration of contaminant in the air space ($RBSL_{air}$), determines the maximum allowable concentration in the subsurface soil source area for each TPH fraction. The RBSL for the volatilization to indoor air pathway ($RBSL_{svin}$) is shown in Equation B-14. Equations B-12 through B-14 were adapted from ASTM RBCA (1995).

$$RBSL_{svin,i}\left[\frac{mg}{kg-soil}\right]=\frac{RBSL_{air,i}\left[\frac{mg}{m^{e}-air}\right]}{VF_{sesp,i}} \qquad \text{(Equation B-14)}$$

Volatilization to Outdoor Air Pathway

The volatilization to outdoor air model is similar to the indoor air model. It assumes contaminants partition into soil pore gas that migrates through the vadose zone to the surface and mixes with the ambient air. Dispersion into ambient air is modeled using a "box model", which is typically valid for source widths of less than 100 feet parallel to wind direction. Steady-state well-mixed atmospheric dispersion of the vapors within the breathing zone is assumed. Other assumptions listed for the indoor air model include linear equilibrium partitioning, steady-state vapor diffusion through the vadose zone and no attenuation of the chemical as it migrates through the vadose zone.

The calculation of a soil RBSL protective of outdoor air quality is similar to that used for the indoor air pathway. A volatilization factor for ambient air (VF_{samb}) is derived for each fraction, using the same effective diffusion coefficient in vadose soils and partitioning factor. Equations B-15 and B-16 were adapted from ASTM RBCA (1995). Default values are provided in Table B-4.

$$VF_{samb,i}\left[\frac{mg/m^3-air}{mg/kg-soil}\right]=\frac{PF_{s-v,i}}{1+\frac{U_{air}\delta_{air}L_s}{D^{eff}_{s,i}W}}\times 10^3\left[\frac{cm^3-kg}{m^3-g}\right] \qquad \text{(Equation B-15)}$$

where:

$PF_{s-v,i}$ = Soil/Vapor phase partitioning factor for i^{th} TPH fraction [unitless]
U_{air} = Wind speed above ground surface in ambient mixing zone [cm/s]
δ_{air} = Ambient air mixing zone height [cm]
L_s = Depth to subsurface soil sources [cm]
$D^{eff}_{s,i}$ = Effective diffusion coefficient in soil for i^{th} TPH fraction [cm^2/s]
W = Width of source area parallel to wind direction [cm]

VF_{samb} is then combined with the allowable concentration of contaminant in the air space ($RBSL_{air}$) to determine the maximum allowable concentration of contaminant in the subsurface soil for each fraction. This concentration, $RBSL_{svout}$, is defined by Equation B-16.

$$RBSL_{svout,i} = \frac{RBSL_{air,i}\left[\frac{mg}{m^{e}-air}\right]}{VF_{samb,i}} \quad \text{(Equation B-16)}$$

DIRECT CONTACT PATHWAYS

For direct exposure routes to soil such as ingestion, dermal absorption and inhalation of particulates, exposure is not limited by C_{sat}. The assumption is made that intake will continue to increase linearly with soil loading beyond C_{sat}. For the direct contact pathways, the Equations B-17 and B-18 are solved (adapted from TPHCWG, 1999 and ASTM, 1995, respectively).

$$HI = \sum_{i=1}^{i=n} HQ_i = \sum_{i=1}^{i=n} \frac{f_i C_{TPH}}{RBSL_i} \leq 1 \quad \textbf{(Equation B-17)}$$

$$RBSL_{ss,i}\left[\frac{ug}{kg-soil}\right] = \frac{THQ \times BW \times AT_n \times 365 \, {}^{days}/_{yr}}{EF \times ED \times \left[\frac{10^{-6} \, {}^{kg}/_{mg} \times (IR_{soil} \times RAF_{o,i} \times SA \times M \times RAF_{d,i})}{RfD_{o,i}}\right] + \left[\frac{IR_{air} \times (VF_{ss,i} + VF_{p,i})}{RfD_{i,i}}\right]}$$

(Equation B-18)

where:

THQ	=	Target hazard quotient for constituent [unitless]
BW	=	Body weight [kg]
AT_n	=	Averaging time for noncarcinogens [years]
EF	=	Exposure frequency (days/year]
ED	=	Exposure duration [years]
IR_{soil}	=	Soil ingestion rate [mg/day]
$RAF_{o,i}$	=	Relative oral absorption factor for i^{th} TPH fraction [unitless]
SA	=	Skin surface area [cm^2/day]
M	=	Soil to skin adherence factor [mg/cm^2]
$RAF_{d,i}$	=	Relative dermal absorption factor for i^{th} TPH fraction [unitless]
$RfD_{o,i}$	=	Oral chronic reference dose for i^{th} TPH fraction [mg/kg-day]
IR_{air}	=	Inhalation rate [m^3/day]
$VF_{ss,i}$	=	Surficial soils to ambient air partition factor (vapor) for i^{th} TPH fraction [unitless]
$VF_{p,i}$	=	Surficial soils to ambient air partition factor (particulates) for i^{th} TPH fraction [unitless]
$RfD_{i,i}$	=	Inhalation chronic reference dose for i^{th} TPH fraction [mg/kg-day]

Similar to the HI calculation, the RBSL equation is solved iteratively to find C_{TPH} such that HI is under the constraint of a target hazard index of 1.0. Default exposure parameters are provided in Table B-2. The fraction specific RfDs are provided in Table B-3.

REFERENCES

ASTM. 1995. Standard Guide for Risk-based Corrective Action Applied at Petroleum Release Sites. American Society for Testing and Materials, West Conshohocken, PA. E-1739-95.

TPHCWG. 1997. A Risk-based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume 3. Selection of Representative TPH Fractions Based on Fate and Transport Considerations.

TPHCWG. 1999. A Risk-based Approach for the Management of Total Petroleum Hydrocarbons in Soil, Volume 5. Human Health Risk-based Evaluation of Petroleum Release Sites: Implementing the Working Group Approach.

APPENDIX C

FIELD DEMONSTRATION PHOTOGRAPHS:

SAMPLING EQUIPMENT AND SITE SAMPLING ACTIVITIES

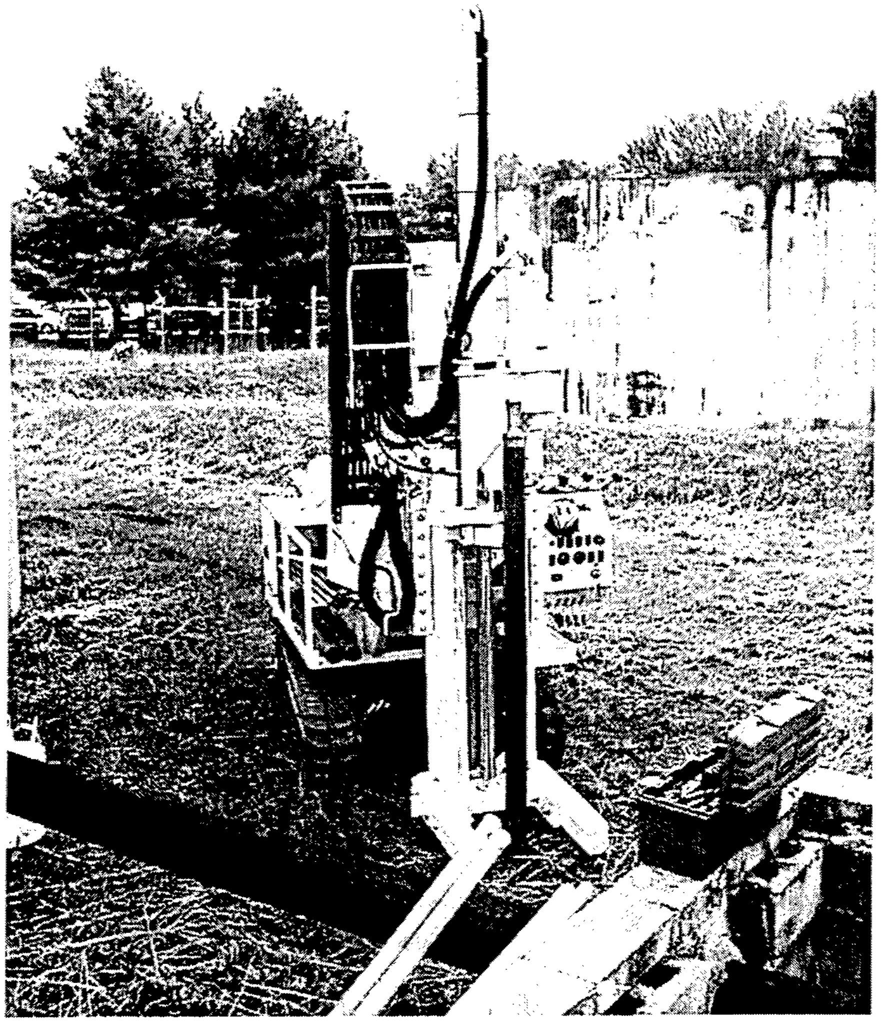


Photo C-1: Track Mounted Remote Drive Geoprobe®

Photo C-2: Field Screening using FID

Photo C-3: Five-Foot Soil Core with Sample Interval Removed and Composited in Bowl